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DATA IN CONNECTION WITH STUDIES OF ENGINEERING EDUCATION, JANUARY, 1930

The following request for information is being sent to institutions which took part in the investigation conducted by the Society through its Board of Investigation and Coordination. The object of this is to secure a measure of the progress which is being made in engineering education in each institution.—Editor.

INFORMATION FOR THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

Institution_____

Institutional Representative_____

NOTE:—Blank pages will permit amplification of answers if space provided is insufficient.

PART I

ADMINISTRATION

1. Undergraduate enrollment in Engineering, Dec. 31, 1929.

	E. E.	M. E.	C. E.	CH. E.	E. M.	I. E.			TOTAL
FRESHMEN									
SOPHOMORE									
JUNIOR									
SENIOR									
SPECIAL STUDENTS									
TOTAL									

NOTE: INCLUDE DAY COURSE ENROLLMENTS ONLY.

									TOTAL
FRESHMEN									
SOPHOMORE									
JUNIOR									
SENIOR									
SPECIAL STUDENTS									
TOTAL									

NOTE: INCLUDE DAY COURSE ENROLLMENTS ONLY.

2. Enrollment of Graduate Students in day courses, Dec. 31, 1929.

	FOR ENGR. DEGREE	FOR M. S.	FOR PH. D.	TOTAL
ENGINEERING				
PHYSICS				
CHEMISTRY				

NOTE: WHERE THE ABOVE FORM IS UNSUITED TABULATE ON SEPARATE SHEET.

3. If evening courses in collegiate engineering subjects are offered give total enrollment, Dec. 31, 1929.

   Number receiving credit toward bachelor degree.....
   Number receiving credit toward graduate degree.....
   Number of students not candidates for degree.....

4. Fees for undergraduate courses. (If different for non-residents of the state, so indicate.)
   (a) Tuition for Engineering Courses.....
   (b) Tuition for Other Courses.....
   (c) Additional charges per year, including laboratory fees, etc., for Engineering Courses.....

5. Cost per Engineering Student per year. (Include only if estimate has been previously made):—
   Remarks as to basis of calculation:.....
6. Administrative Officers and Teachers of Engineering Students.

	NUMBER	SALARY		
		MAXIMUM	AVERAGE	MINIMUM
ADMINISTRATIVE OFFICERS (Incl. Dean)				
DEPARTMENT HEADS				
PROFESSORS				
ASSOCIATE PROFESSORS				
ASSISTANT PROFESSORS				
INSTRUCTORS				
ASSISTANTS				
* OTHERS				

* NOTE: PLEASE SPECIFY.

7. Approximate investment in laboratory equipment used for instruction in engineering.
8. General Remarks on Part I.....

PART II

STUDENT SELECTION AND EDUCATIONAL GUIDANCE

1. Contacts with Secondary Schools.
   (a) If systematically maintained please state nature of these contacts
   .....
   (b) Have these contacts resulted in improvements in quality and fitness of matriculants, or in other desirable results?.....

2. What is your process of selection of Freshmen?.....

3. Admissions.
   (a) Total number of Freshmen admitted this year, up to Dec. 31, 1929.....
   (b) Number admitted with conditions.....
   (c) Number of Students admitted to advanced standing.....
      1. From other Engineering Schools.....
      2. From other Collegiate Schools.....
      3. Transfers from other courses in your institution.....
   (d) Number of Freshmen who have failed to present required units in the following subjects:

	UNITS REQUIRED	NUMBER FAILING TO PRESENT REQUIRED UNITS
ALGEBRA		
SOLID GEOMETRY		
TRIGONOMETRY		
PHYSICS		
CHEMISTRY		

4. Educational Guidance and Orientation of Freshmen.
   (a) If one or more of the following methods are used please indicate by a check mark.
   ..... "Freshmen Week"—Number of days.....
   .....Engineering Problems Course.
   .....Required Orientation Lectures.
   .....Series of unrequired talks or lectures.
   .....Faculty advisers.

   (b) Other methods.....

5. Eliminations.
   (a) From the original group of Freshmen:—

	CLASS BEGINNING IN FALL OF:		
	1923	1924	1925
NUMBER OF FRESHMEN ADMITTED			
NUMBER REMAINING AFTER 1 YEAR			
NUMBER REMAINING AFTER 2 YEARS			
NUMBER REMAINING AFTER 3 YEARS			
NUMBER GRADUATING IN 4 YEARS			
NUMBER GRADUATING IN 5 YEARS			
NUMBER STILL IN COLLEGE			

(b) Please tabulate below the total enrollment at the beginning of the school years indicated.

FRESHMEN	1923 ———	1924 ———	1925 ———
SOPHOMORES	1924 ———	1925 ———	1926 ———
JUNIORS	1925 ———	1926 ———	1927 ———
SENIORS	1926 ———	1927 ———	1928 ———
NUMBER GRADUATING	1927 ———	1928 ———	1929 ———

6. (a) Do the college records indicate the causes for eliminations.....

(b) If any analysis of causes for eliminations has been made please state result.....

7. General Remarks on Part II.....

PART III

COURSES AND CURRICULA

1. Please state the number of semester hours credit required for graduation

	E. E.	M. E.	C. E.	CH. E.	E. M.	I. E.		
MATHEMATICS								
PHYSICAL SCIENCE								
ENGLISH								
MODERN FOREIGN LANGUAGES								
ECONOMICS								
TECHNOLOGICAL SUBJECTS,								
MAJOR BRANCH								
OTHER TECHNICAL SUBJECTS								
SHOP								
DRAWING								
ELECTIVES								
PHYSICAL & MILITARY EDUCATION								
TOTAL								

MATHEMATICS								
PHYSICAL SCIENCE								
ENGLISH								
MODERN FOREIGN LANGUAGES								
ECONOMICS								
TECHNOLOGICAL SUBJECTS, MAJOR BRANCH								
OTHER TECHNICAL SUBJECTS								
SHOP								
DRAWING								
ELECTIVES								
PHYSICAL & MILITARY EDUCATION								
TOTAL								

2. What significant changes in educational policy or curricula have taken place in the last five years.
3. What significant changes have taken place in the last five years regarding the number and quality of graduate courses .....
4. Where is the administrative control of graduate work placed and how is it supervised?
5. General Remarks on Part III.....

IV

EDUCATIONAL DEVELOPMENT

1. Have any significant changes been made in teaching methods, and if so give particulars.....
2. Have any experiments in teaching methods been conducted? If so, give particulars.....
3. Normal teaching load of Engineering Teachers expressed in total clock hours (class periods of fifty to fifty five minutes each) per week in actual contact with students in class or laboratory.

	Hours per Week
Department Heads.....	.....
Professors.....	.....
Associate Professors	.....
Assistant Professors	.....
Instructors	.....
Others	.....

4. Research and Publications.
   (a) Number of Research Fellowships.....
   (b) Number of part and full time assistants devoting time to research.....
   (c) Number of published bulletins or monographs on research, exclusive of articles in periodicals, except where reprinted. (Within the last five years).....
   (d) Total expenditures for research, 1928-1929 (if available) .....
5. S.P.E.E. Summer Schools.
   (a) Has your institution defrayed any of the expenses of the representative to these schools?
   (b) What is your impression as to the values received by those who have attended?.....
6. General Remarks on Part IV.....

PART V

GRADUATE PLACEMENT AND DEMAND

1. Methods employed in placement of seniors.
   (a) If one or more of the following methods are used, please check.
   .....Personnel or Placement Officer.
   .....Dean of Men or similar Administrative Officer.
   .....Department Heads.
   (b) Give brief statement the type of records kept for placements purposes.....

2. How is information of employment opportunities conveyed to seniors and undergraduates?

3. Opportunities for Engineering Graduates.
   Please give what information you have under the following:—
   (a) Number of Senior Engineering Students, 1929 .....
   (b) Number of Industries visiting campus, 1929 .....
   (c) Number of contacts through correspondence or other means .....
   (d) Number of positions offered. .....

4. From what information is available, please list below the number of positions accepted at the different initial starting salaries.

MONTHLY RATE	NUMBER OF POSITIONS

5. If any studies of salary progress of graduates have been made in the last five years, list them. Please include the results of the studies.
6. General Remarks on Part V.....

McGILL UNIVERSITY

CHAS. M. McKERGOW

Professor of Mechanical Engineering

Nestling right in the shadow of Mount Royal which stands sentinel over Canada's metropolis city of Montreal, lies McGill University, one of the oldest and foremost of the Dominion's institutions of higher education. Within but a short distance of the very center of the country's business activity, yet in itself a compact unit which can shut itself off entirely from the noise and worries of commercialism, the university occupies a position which is singularly advantageous for its varied needs.

Like the country in which it stands, McGill has a history in which rapid development, particularly in recent years, is outstanding. Starting with but small beginnings the university has grown and expanded until its reputation has spread, through its graduates and through its accomplishments, into all parts of the globe. Students from all countries are attracted to its halls of learning, some attend the famous medical school, others to take the engineering courses, and many more to study for the various degrees that McGill offers in numerous branches of learning.

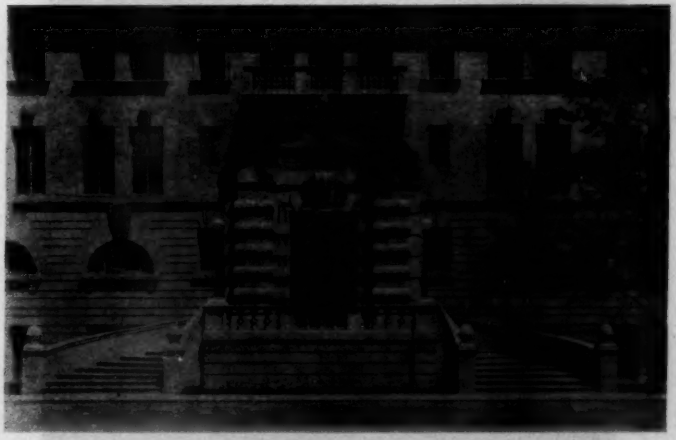
It was James McGill, a Scottish-Canadian business man, who made the foundation of the university possible by setting aside his estate together with a sum of ten thousand pounds to be devoted to the establishment of such an institution. This was in 1821, but it was some years before anything was actually done in an undertaking which was then considered as hazardous as it was difficult. The land which the founder had left, though now right in the center of the city, was then far out in the country, and it was some time before the advantages and possibilities of the site were realized.

In 1829, however, McGill University became a working institution by the formation of a medical faculty which granted its first degree four years later; but this course was conducted in buildings which were at that time in the actual city down on the banks of the St. Lawrence River. The first building to

McGILL UNIVERSITY.
GENERAL VIEW.

be erected on the bequeathed estate was the Arts Building, called McGill College, which is still preserved as the central portion of a new and greatly enlarged structure which now stands at the head of the beautiful avenue which passes down the center of the Campus.

Progress was still slow, due mainly to divided direction of the affairs of the university, but in 1855 Sir William Dawson assumed control and from then on for the next thirty-eight



MAIN ENTRANCE MACDONALD ENGINEERING BUILDING.

years McGill's journey became a triumphant march. In 1866 the Faculty of Arts was widened to include engineering lectures; seven years later two additional buildings were completed; in 1872 the medical faculty was transferred from its town site to the new university buildings. Internal and external progress was continued all through the years that Sir William Dawson remained at the helm.

He was succeeded in 1893 by Sir William Peterson, who guided the fortunes of McGill on until the time of the Great War. The same expansion and general improvement of the existing faculties continued under his guidance. In 1899

E. W. BEATTY, K.C., LL.D.

PRESIDENT, CANADIAN PACIFIC RAILWAY; CHANCELLOR OF THE UNIVERSITY.

Lord Strathcona, then chancellor of the university, built the Royal Victoria College, which houses the women students at McGill, and two years later the Strathcona Medical Building. At the same time Sir William Macdonald, one of McGill's greatest benefactors, was taking an interest in this constructive advance, and buildings at McGill which remain to his memory include the Chemistry Building, the Engineering Building, the Physics Building, the Students' Union, and the one section of the university that lies outside the city of Montreal, the Macdonald agricultural college at Ste. Anne de Bellevue, perhaps the greatest gift of this generous philanthropist.

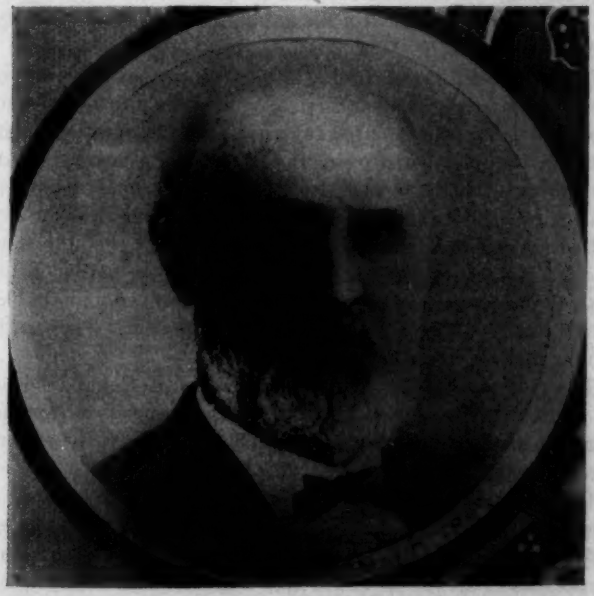
New buildings have been added since that time, old ones have been renovated and modernized to meet the needs of the 2,500 undergraduate students in attendance in the various faculties. The splendid Redpath Library, with its collection of over 300,000 books, many of them of great value, the Redpath and McCord National museums, the Pathological Institute, the Biological Building and a new edifice for pulp and paper research work are among those that have not already been mentioned. The fine Molson Memorial Stadium meets many of the athletic needs of the undergraduates.

The compactness of the institution, with all the buildings with the exception of Macdonald College grouped closely together, is of great benefit to the student. The medical undergraduate finds the medical building, the Pathological Institute, the Biological Building and the Royal Victoria Hospital all within a stone's throw of one another; the student in engineering has but to step next door to reach the chemistry and physics departments; while the Arts man has the library right in front of him, the museums close at hand. Experimental and survey work in the science course is carried out at Macdonald College during the summer months, but apart from this all the students at the latter institution live in the college buildings out at Ste. Annes.

The beauty of the main campus, particularly in the summer months, is widely heralded, and indeed the central avenue with the huge historic trees on either side forming a majestic

SIR ARTHUR CURRIE, G.C.M.G., K.C.B., LL.D.
PRINCIPAL AND VICE CHANCELLOR.

arch overhead, is a sight that is not soon forgotten. At the entrance to the university grounds are the Roddick Gates, in memory of Sir Thomas Roddick, one of McGill's distinguished medical graduates.



SIR WM. MACDONALD.
DONOR OF THE ENGINEERING BUILDING.

McGill University is an independent, non-sectarian institution, and being privately endowed is in no way under Government control. It exists by royal charter of the British Government and thus occupies a singular position in Canada. In its organization it follows the general lines of the universities of Scotland, the teaching and examinations being carried on by different faculties, all of which are under the control of the university.

The present principal is General Sir Arthur Currie, who commanded the Canadian Army Corps during the Great War.

REPORT OF THE MEETING OF THE INSTITUTIONAL DIVISION

A meeting of the Institutional Division was held on June 20, 1929, in connection with the annual meeting of the Society. Vice President C. C. Williams presided.

Chairman Williams: In 1927 the Committee on Policy of the Society recommended that a Committee of the Institutional Division be appointed to investigate the question of extending the membership in the Division to non-collegiate institutions, that is, to technical trade schools and perhaps to some high schools, in order that the Society might cooperate with that group of institutions more fully and that the work of such institutions might be coordinated more satisfactorily with the promotion of engineering education. I find that no action has been taken with regard to this matter. The matter is now before you.

The motion that a committee of the Institutional Division be appointed to study and report on the propriety of extending the institutional membership of the Society to non-collegiate institutions was carried.

Chairman Williams: That committee will be appointed in due time. The nature of the program this afternoon has been influenced by two circumstances. The first of these circumstances was that the Board of Investigation and Coordination proposed to the Institutional Division that a study be made of two questions:

First: The coordination of preparatory engineering education and

Second: Personnel problems.

The Board appropriated certain funds for carrying on studies in these two subjects. The second influence which tended to shape the program for this afternoon was a meeting, of a considerable number of men from technical schools and from industries, called by President Kimball last November in New York to study the question of personnel instruction in engineering colleges.

PRELIMINARY REPORT OF THE COMMITTEE ON COORDINATION OF PREPARATORY AND ENGINEERING EDUCATION

T. M. FOCKE, *Chairman*, O. M. LELAND, H. H. JORDAN, H. W. MILLER

In appointing this committee Dean Williams suggested the following assignment:

"To Study Predictive Indices of Probable Success on the Part of Students in Engineering Courses.

"The following procedure is suggested; it may be modified or amplified as the committee may see fit.

"*a.* Collect bibliography and summarize same on the correlation of preparatory school grades and college grades in engineering courses.

"*b.* Investigate the reliability of preparatory school grades in mathematics and physics as an index of success in an engineering curriculum. Ascertain per cent correlation.

"*c.* Investigate the reliability of entrance examinations as an index of success in an engineering curriculum.

"*d.* Summarize findings with regard to predictive value of aptitude and placement tests.

"These studies should be made at representative institutions where the data are readily available."

It is evident from this that it was intended that the criterion of success in the engineering school was to be college grades. If we had followed the usual procedure, we would have computed the coefficient of correlation between high school or test grades and the college grades for the first term. This would have given us a number which would be a measure of "success" in college only as far as the grades for the first term could be used to designate this. It seemed to your committee that a better, and at the same time simpler criterion of success would be *survival*. The thing that all the colleges are aiming at is the graduation of the students who come to them. The courses are laid out so that they can be completed in four years. Complete success therefore in an engineering course would be graduation in four years. Of course some men do better work than others and there is always a great gap between the man at the head and the man at the foot of the

class, but even the man at the foot has succeeded where many have failed. Graduation on time is consequently a simple criterion of success in college. It is a very definite thing and not much subject to the opinion of the investigator. With this idea of what constituted success, your committee has followed a very useful method frequently used in engineering, that of making an approximation. Instead of using graduation on time we have used the reaching of the senior year on time. Elimination in the senior year is usually quite small and by using this approximation, it takes only three years to get results instead of four.

It was further suggested that the investigations should be made at a number of representative institutions, but owing to lack of time, it has been necessary to restrict nearly all the work to be reported on to one institution, Case School of Applied Science. For about ten years, the chairman has been collecting information regarding elimination and was able to get the clerical help needed to tabulate the results.

As a basis for the prediction of success, it was decided to use only such material as would be in hand before the student was admitted to college, or such other material as might be obtained before admission, in other words high school records and the results of entrance tests or examinations.

In considering what might be used as a basis for prediction, all of us would instinctively think of preparation in mathematics and the easiest material to obtain on this subject would be the high school grades. Like many others, I was quite skeptical as to the comparability of grades from different schools, but decided to see what might be possible to get. We therefore computed the average of the grades on the three units which we require for admission. Then the class was ranked on this basis and divided into fifths. Then the number of men who reached the senior year on time from each fifth was determined. For ten years I have been noting when a student left his class what I thought was the cause. The diagrams show what part of each group I thought left the class on account of scholarship. Please remember, throughout, that this division is only my opinion. The decision was

however made at the time the boy left college without any idea that the results would be used in such a report as this. The total elimination is definite and not a matter of opinion.

It should be further remembered that while the classes number from 175 to 200, when they are divided into fifths the groups contain only 35 to 40 men and that a change of one man will make a noticeable change in a diagram.

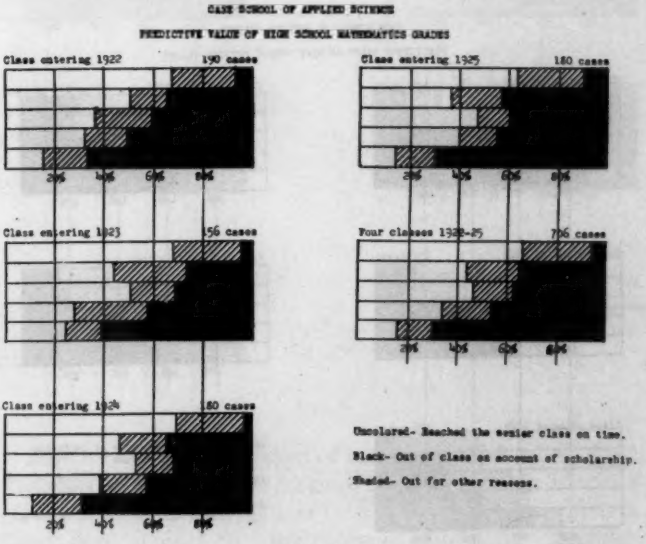


FIG. 1

In making any kind of scientific observations it is always necessary to repeat the measurements in order to be sure that the results are not accidental. Whenever possible, the data have been given for several classes. To be valuable, a test or set of grades should show a much higher percentage of survivals at the top than at the bottom of the class. The greater the difference the better. The diagrams for different classes should also be considered.

This shows the predictive value of high school mathematics grades. The results for the top fifths of the four classes agree excellently, as do also the lowest fifths with the exception of the class entering in 1923. Even in this case a change of only two or three men would make it like the others. The three middle fifths seem to be erratic. In the highest fifths the grades run from about 90 up and in the lowest fifths from around 80 down.

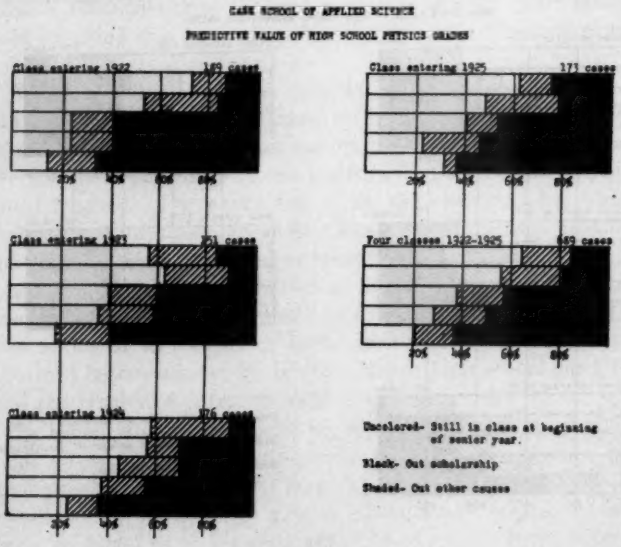


FIG. 2

This shows in a similar manner the predictive value of grades in high school physics. These diagrams are not so consistent at either the top or the bottom but are somewhat better in the middle than the mathematic grades. As we are much more interested in the bottom and top of a class than the middle it is evident that the mathematics grades are much more valuable for our purposes.

We also tried out the average of the mathematics and physics grades but results were no improvement upon the mathematics alone.

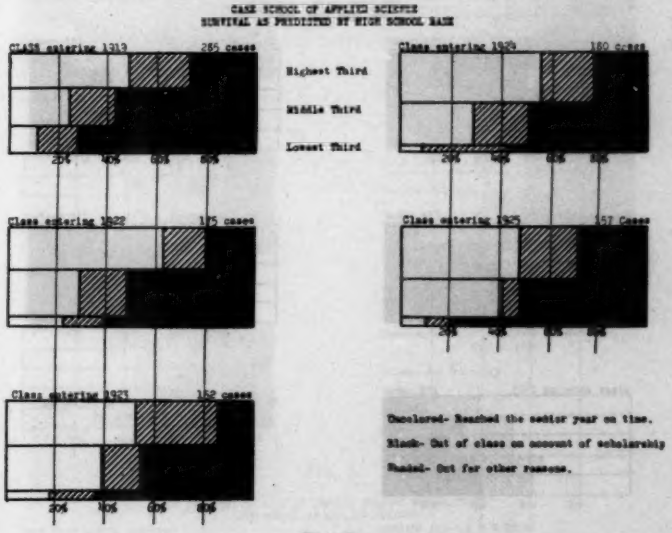


FIG. 3

Here we have the prediction of rank in the high school class. The class entering in 1919 is shown together with the last four classes because it was the last in which men from the lowest third were allowed to enter without restriction. Recently lowest third men have only been admitted by examination. It is quite evident that our examinations do not pick men of superior quality from the lowest third but they have cut down the number and incidentally our total elimination has been materially reduced.

The five classes give quite consistent results, particularly at the lower end of the scale.

The Army Alpha test was given to the S. A. T. C. class in January, 1919, but to the other classes at entrance. The results are not consistent and there is very little distinction be-

tween the top and the bottom of the classes. It is therefore of practically no value in the prediction of survival.

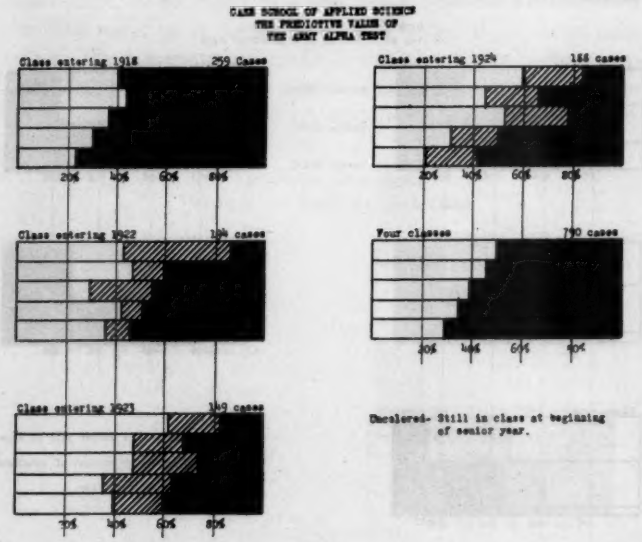


FIG. 4

We have the results of the Thurstone Intelligence Test (S. P. E. E. No. IV) for four classes but the diagrams for the three shown here are so discordant that it did not seem worth while to compute the other class. The Council on Education tests seem somewhat better, there is more distinction between the top and bottom of the class, but the results are not very consistent. We have used this test on our present junior class and the Ohio College Association tests on the two lower classes. None of these promise any better results as the correlation coefficients with the first term grades are relatively low.

Sometime in 1922 it was discovered that the S. P. E. E. algebra test had predicted quite well the survival of the men who took it in 1919. Consequently we gave an algebra test of our own to the class entering in 1923 and another in 1924.

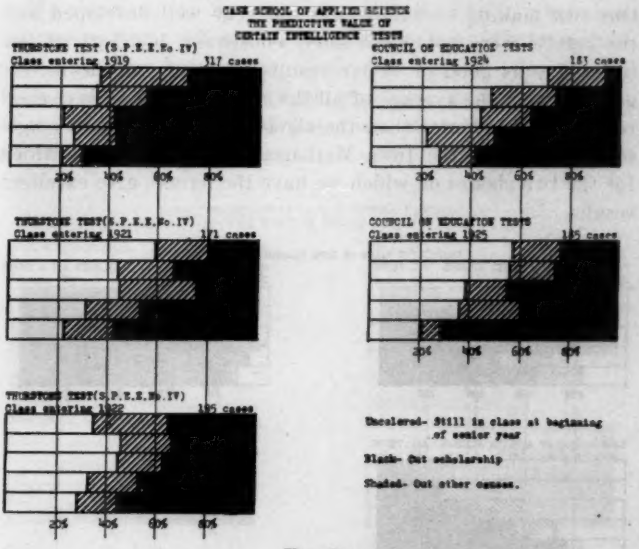

CASE SCHOOL OF APPLIED SCIENCE
THE PREDICTIVE VALUE OF
CERTAIN INTELLIGENCE TESTS
THURSTONE TEST (S.P.E.E.No.IV)
Class entering 1919
317 cases
COUNCIL OF EDUCATION TESTS
Class entering 1924
181 cases
THURSTONE TEST(S.P.E.E.No.IV)
Class entering 1921
171 cases
COUNCIL OF EDUCATION TESTS
Class entering 1925
135 cases
THURSTONE TEST(S.P.E.E.No.IV)
Class entering 1922
195 cases
20%
40%
60%
80%
Uncolored- Still in class at beginning of senior year
Black- Out scholarship
Shaded- Out other causes.

FIG. 5

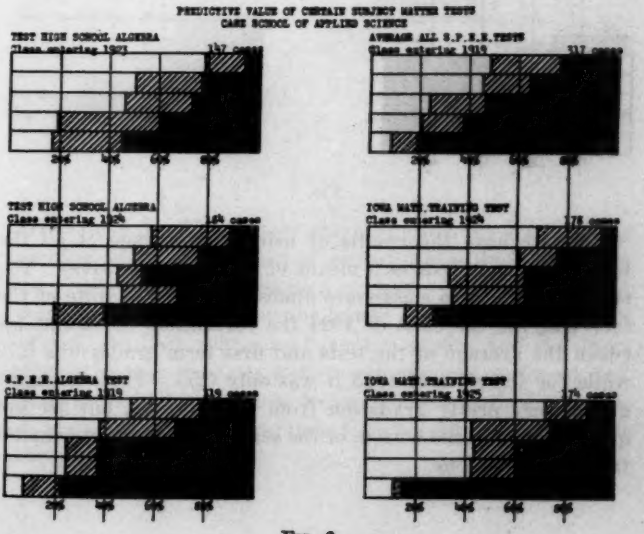

PREDICTIVE VALUE OF CERTAIN SUBJECT MATTER TESTS
CASE SCHOOL OF APPLIED SCIENCE
TEST HIGH SCHOOL ALGEBRA
Class entering 1923
AVERAGE ALL S.P.E.E.TESTS
Class entering 1919
317 cases
TEST HIGH SCHOOL ALGEBRA
Class entering 1924
IOWA MATH.TRAINING TEST
Class entering 1924
178 cases
S.P.E.E.ALGEBRA TEST
Class entering 1919
139 cases
IOWA MATH.TRAINING TEST
Class entering 1925
174 cases
20%
40%
60%
80%

FIG. 6

Our test making technique was not very well developed and the results were not particularly consistent, but both of our tests gave as good or better results than any of the intelligence tests. The average of all the S. P. E. E. tests gave good results but not better than the algebra alone. The best single tests seem to be the Iowa Mathematics Training tests which for the two classes on which we have the figures give excellent results.

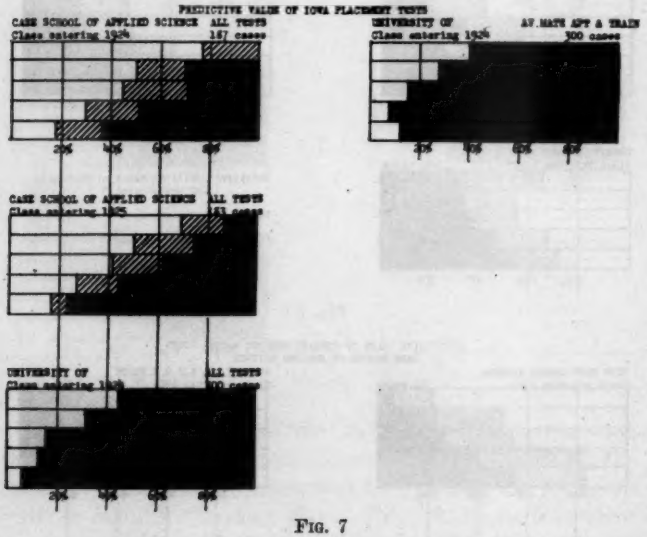

PREDICTIVE VALUE OF IOWA PLACEMENT TESTS
CASE SCHOOL OF APPLIED SCIENCE ALL TESTS
Class entering 1924 167 cases
UNIVERSITY OF AV.MATH APT & TRAIN
Class entering 1924 300 cases
20%
40%
60%
80%
CASE SCHOOL OF APPLIED SCIENCE ALL TESTS
UNIVERSITY OF ALL TESTS

FIG. 7

Here we have the results of using the average of all the Iowa Placement tests as a means of predicting survival. The results for the two classes are almost identical in spite of the fact that for the class of 1924 the correlation coefficient between the average of the tests and first term grades was 0.75 while for the class of 1925 it was only 0.55. These averages give a very pretty gradation from fifth to fifth, but are not quite so good at the bottom of the scale as are the mathematics training tests alone.

We also have the figures for another institution where conditions are quite different from those at Case. We have, however, the same very strong distinction between the top and bottom of the class and uniform gradation from fifth to fifth. It would be interesting to know how the absolute scores at the two institutions compared.

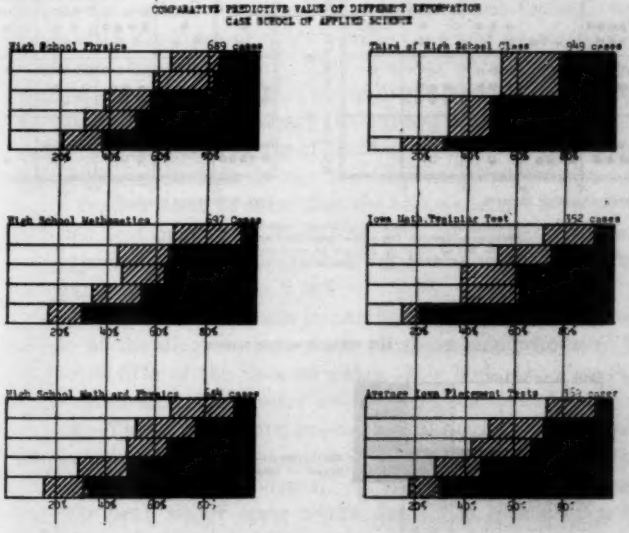


FIG. 8

Here we have side by side the composite diagrams of the preceding slides, leaving out of consideration the intelligence tests. Each of these sets of data evidently gives quite a good prediction of survival when the larger groups are considered. However, the high school mathematics grades and the Iowa mathematics training tests seem to give the best and most consistent results. Both of these deal with mathematical preparation and one would think that they might correlate quite highly.

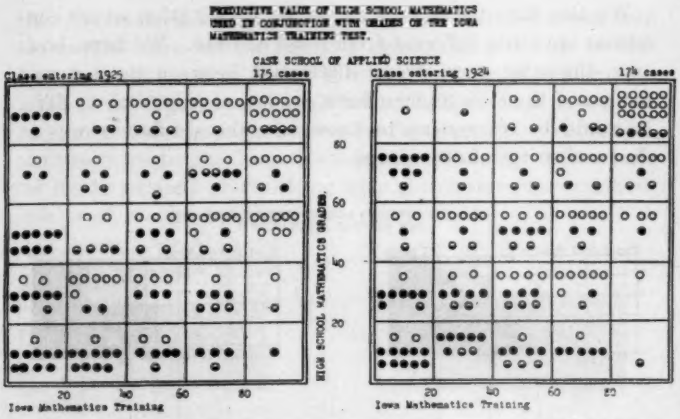


FIG. 9

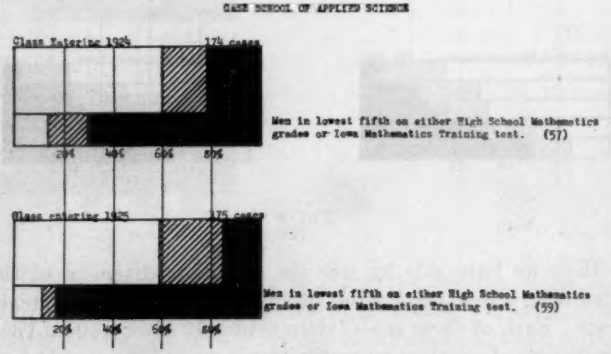


FIG. 10

This shows the scatter diagram of the high school mathematics grades and the Iowa mathematics training tests for two classes. It is quite evident that the correlation is not very high. Each circle represents one student and its posi-

tion shows his standing on each set of grades. Where the circle is not colored, the student reached the senior year on time, where black he dropped out on account of scholarship and where half black for other reasons.

Of course the high school grades are supposed to be the measure of the ability of the student to carry on his mathematical work from day to day and perhaps pass an examination at the end of the term. The training test, though, was taken after the lapse of quite a little time and measures how much has been retained. The diagram seems to indicate that the ability to absorb and the ability to retain mathematics are almost equally necessary to success in an engineering course. Weakness in either of these abilities seems to be fatal and weakness in both is not much worse than in one. It would further seem to show that the test could not be used to pick the best men from those who had low grades at school. Our experience with examinations for lowest third men seems to confirm this conclusion.

This shows the same facts in another form. Here the lower section of the diagram represents all those men who were in the lowest fifth of the class on either their high school mathematics grades or of the score on the Iowa mathematics training test. The upper section represents all the rest of the class. The two diagrams are so much alike that it seems that the coincidence must be accidental. It will be interesting to see how our next senior class works out. The group of poor students picked out by this means might be somewhat enlarged if we included those students who were low on the mathematics aptitude test, but the percentage of men reaching the senior year would be somewhat increased. The group used on these diagrams seems to include all the men who were in the lowest third of their high school classes.

Conclusions

1. The general intelligence tests that have been tried at Case are of very little value in predicting survival of engineering students.

2. The average of high school mathematics grades give very good predictions that men at the lowest end of the scale will not survive.

3. Students from the lowest third of the high school classes are very poor risks.

4. High school physics grades give a fair prediction of survival but do not predict failure at the lower end of the scale as well as do the mathematics grades.

5. Nothing is gained in accuracy of prediction by averaging high school mathematics and physics grades.

6. Tests on algebra seem to give good predictions and in particular the Iowa mathematics training test.

7. The S. P. E. E. tests of 1919 when averaged gave a good prediction of the survival of that class when the war conditions at that time are taken into account.

The average of all the Iowa placement tests give a very definite idea of the chances of survival of the different fractions of the class.

9. By taking all those students who are in the lowest fifth of the class on either the high school mathematics grades or the Iowa mathematics training test, a group as large as a third of the class can be named not more than one in seven of whom will reach the senior class on time, whereas sixty per cent of the rest of the class will survive.

PRELIMINARY REPORT OF THE COMMITTEE ON INDUSTRIAL APTITUDES OF TECHNICAL GRADUATES

A. M. GREENE, JR., *Chairman*, R. E. DOHERTY, E. A. HITCHCOCK, J. P. JACKSON, D. S. KIMBALL, R. I. REES, E. B. ROBERTS

The committee was appointed on December 28, 1926, and in its instructions it was directed to study the subject:

"RECOGNIZING NATIVE EXECUTIVE ABILITY"

Our instructions contained the following:

"The following procedure is suggested. It may be modified or amplified at the discretion of the committee.

"1. What, if any, are the evidences of latent or embryonic executive or managerial aptitude manifest and recognizable in engineering students?

"*a.* Correlation between scholastic achievement and success in executive or managerial positions in industry.

"*b.* Correlation between scholastic achievement plus participation in student activities, (*a*) student organizations offices, (*b*) student enterprises, (*c*) athletics, (*d*) social and executive success in industry.

"To be of most discriminative value, the success or failure should be of a certain number of cases (say 30) of men who had made good as executives and a similar number of those who had been definitely *given a chance* and failed. Studies made by United States Army would be pertinent.

"2. If native executive aptitude could be identified with a reliability of say 75 per cent in senior students at time of graduation, to what extent would such knowledge be definitely usable by industries under present personnel methods? Under possible revision of personnel methods?"

The committee has held two meetings in New York City and in working out their problem they have decided to study the records of men in industry and the records of graduates of complete lists of two classes in mechanical and electrical engineering from three engineering schools. The first records will give us men from many different schools in one industry, while the latter records will give us complete classes from one institution in different industries. The records of men from the American Telegraph and Telephone Company, the General Electric Company, the New York Edison Company and its allied companies, and the Westinghouse Electric & Manufacturing Company, Cornell University, Ohio State University, and the Rensselaer Polytechnic Institute will be studied.

In the industrial group the study will include also the examination of the records of men who have not been advanced in executive work, although their initial employment was such that they should have advanced in this field if the necessary ability had been developed.

The school list will include the successful men as well as those who have not developed.

In this study each member of the committee is permitted

to follow out his own methods of collecting the data from this group to be studied. The committee at its first meeting decided that they would endeavor to obtain the following data for each record:

Data of Graduation—
Class Standing:
Upper tenth
Upper third
Middle third
Lowest third
Extra Curricular Activities in:
1. Athletics
2. Social
3. Literary
4. Music
5. Managerial
The amount of these activities should be graded as
Substantial
Some
None
Earnings of student days
Summer work of student days
Positions held at varying times
Salary at end of each two year intervals
Civic activities
Size of present family
Systematic study since graduation.

The committee in fixing success in executive work has determined on using the nature of the position held at present as a measure of success, and by relative salaries within the same organization or for those of about the same years of experience, to obtain a still further estimate of success. It will try to confine itself to the study of those who have distinctly executive duties. It will also consider those unsuccessful in executive work who have had opportunities for advancement in such fields of endeavor but who have not received

promotion to these positions and who have remained in positions of little or no executive responsibility. The committee has not included in its study any of those extraordinary, successful individual workers who have not entered into executive activities.

The committee has been unable to collect all of the data desired for this study and this report is to be considered as a preliminary statement of its investigation From the data before it, it may be said in general that there are no absolute traits or characteristics in the graduate which distinctly mark one as a future executive. On the other hand there are trends which indicate success in executive activities. It is believed, however, that those same trends would be indicated were we to seek predictive characteristics from which to judge ability and future success in another field of endeavor.

We will first consider scholastic achievement as a predictive indicator of future success in administration. In a list of fifty successful men in industry it is found that 18 per cent were in the first tenth of their classes at college, 44 per cent were in the remainder of the first third, 32 per cent in the middle and 6 per cent in the lowest third; while in the list of twenty unsuccessful men 47 per cent were in the lowest third, 38 per cent in the middle third, 10 per cent in the upper third, and 5 per cent in the first tenth. Of the most successful six men, two happened to be in the top tenth, one in the middle third, and one in lowest third. Two were in the remainder of upper third of their classes.

In the Class of 1912, from two engineering schools, of twenty successful men 20 per cent were in the first tenth of the class, 30 per cent in the remainder upper third, 30 per cent in the middle third and 20 per cent in the lowest third. Of the six unsuccessful men as executives 33 per cent were in the upper third, 50 per cent in the middle third, and 17 per cent in the lowest third.

In the Class of 1918, of twenty-five successful men 12 per cent were from the first tenth, 28 per cent from the remainder of the first third, 36 per cent from the middle third, and 24 per cent from the last third. Of the six unsuccessful men 17

per cent were in the first tenth, 17 per cent from the remainder of the first third while 60 per cent were from the last third.

This indicates in general that scholastic record is an excellent guide, as in most cases the successful executives come from the upper sections of the classes. The unsuccessful men in general are from the lower sections of the classes, although some failures are found from men in the upper third. This result was found by Colonel Rees in his extensive study made a year ago.

The extra curricular activities of the students do not seem to indicate executive ability. In industry the most successful men did not take much time for activities other than those of the classroom. In general, of the successful men 25 per cent report having participated in a major way in campus activities, while 20½ per cent report some minor form of activity while 54½ per cent report no form of extra curricular work.

In the list of non-successful men about the same percentage report no activities. The others having some form of minor interest. None of these men, however, reported a major interest in campus affairs. The data from the colleges are not complete regarding extra curricula work.

The desire to do work in summer or before entering the employ of an industry has something to do with showing executive ability, as fifty per cent of the successful men from industry have had some such experience, while of the unsuccessful men only 15 per cent have had previous experience. From the school records, however, we find that both successful and unsuccessful men show a desire to have experience from summer work. Of forty-seven successful students more than three quarters report outside work during their engineering courses, and eighty-five per cent of the unsuccessful men report this outside experience.

In the matter of self-support or partial self-support, the results of the study of the men in industry is shown in the following table:

EARNINGS AT COLLEGE

	Successful Men	Unsuccessful Men
Two thirds of expenses or more	27%	31%
One third to two thirds of expenses	25%	31%
One third or under	26%	13%
None	28%	25%

The college data show that practically the same number of men have been required to earn part of their expenses as the number who have not had this need.

If we include all earnings it is seen that the majority of men in industry have been compelled in student days to earn at least part of their expenses.

In considering the opinion of faculty members regarding twenty-one successful men, 75 per cent were rated as having executive ability by their teachers, while twenty-five per cent were rated as having no executive ability or doubtfully having ability. Of the six unsuccessful men only 16 per cent were rated as having executive ability, with 16 per cent of doubtful executive ability, and 67 per cent of no executive ability.

Of the successful executive men of the classes of 1918, 72 per cent were so predicted by the faculty, while 28 per cent showed no executive ability as students. Of the unsuccessful men 22 per cent gave promise of executive success as students and 78 per cent showed a lack of promise as students.

It is believed that faculty opinion may give this predictive method of future success, although it may be that this faculty opinion is strongly biased by scholastic achievement, and more study must be put on this element of our investigation.

This preliminary report is based on a part of the data which we collected and the committee desires to be continued so that it may make a study of further information which it will obtain from its members.

The committee feels that from its present studies success depends so largely on the mental traits shown by students that scholastic achievement and opinions of faculty members regarding personalities are the most important factors by which to predict future success as executives and as men.

The committee has discussed the advisability of all schools

using systematic personal grading of students as to personal characteristics by faculty members, as is done by some schools. The committee also believes that the engineering teachers should endeavor to improve the personalities of students who show a lack of those traits which are found among successful men.

Discussion

H. L. Davis (New York Telephone Company): I would like to focus on certain items of the report and bring them out briefly.

The report says that from data there are no absolute traits or characteristics in the graduate that distinctly mark one as a future executive.

It also says that there are trends that indicate success in executive activities. These same would probably indicate success in other endeavors.

Also it says that the extra-curricular activities do not seem to indicate executive ability. In other words, they are more or less all over the lot. The successful men have relatively the same proportion of club and team activities to their credit as those that have not all of these things and may have worked their way through school.

It also says that success depends very largely on mental traits. Undoubtedly, that is so. Success in itself is a complex, and success does not depend on one trait alone. I think it is going to be very difficult ever to segregate the traits and characteristics of an individual, whether it is his ability to study or whether it is his personality or many other things, some of which also are complexes, and say that success depends—the major portion of it—on this or on that. Success is a complex and we must consider all the factors of that complexity.

It is those other factors, other than scholarship, I think, that we seek. I think it has been fairly well demonstrated, and I think we all agree, that a man, when he does a job well, is wanted for his brain power. However, there are other things which are very vital too.

This morning, Mr. Fitzgerald in the Civil Engineering

meeting brought out the fact that technical men must have much more than just the highest standard of technical work ability to be railroad men. Mr. Burgess, who is a contractor, said in order to exist he must get work and he must sell himself. Those are just two little illustrations.

The report also says that scholastic achievement and the opinions of faculty members regarding personalities are important indices by which to predict success.

I agree to that also, but what we want to know is on what these faculty members and others base those opinions. That is to say, something that goes beyond the scholastic standing which we are all ready and willing to agree is rather a necessity towards success, must be there, particularly in certain lines.

I feel that those things, those traits and characteristics, should be analyzed—those which are aside from scholastic standing. Those traits and characteristics make some people successful who have no scholastic standing. The lack of these traits and characteristics make some people unsuccessful even if they have the highest scholastic standing.

We must never forget that another factor to remember is to rate the raters. People do the rating but we must first make them demonstrate that they are the people who should do the rating and that they are able to rate. Let us assume that good standing is very helpful and then go after these personal factors.

I would like to see the study continued. As I read it this morning it points out that a study has been made.

REPORT OF THE COMMITTEE ON COLLEGE INSTRUCTION IN INDUSTRIAL RELATIONS

R. L. Sackett, *Chairman*, D. S. Kimball, J. W. Roe, J. E. Walters
J. W. Hallock, F. E. Ayer.

The importance of instruction in this subject for all engineering students was emphasized by Mr. Lewisohn at the Schenectady meeting in 1925.

Since that time, progress has been made in various engineer-

ing colleges but this is the first time that a committee has been appointed and instructed to report on a scheme for instruction in this field.

When your committee was appointed, Dean C. C. Williams, Chairman of the Institutional Division, suggested the following program:

"*a.* Recommend a list of books and magazines on personnel administration.;

"*b.* Recommend a small list of books to be read by all engineering students.

"*c.* Make a recommendation as to amount and character of instruction in industrial relations desirable for various groups of students.

"*d.* What is the relative efficacy of formal courses, seminar, etc., in instruction in industrial relations?

"*e.* If feasible, collect 'case' material for use in personnel instruction and make same commercially available.

"*f.* What can be done specifically during a college course to develop 'personality' in students?

"*g.* Do graduates from 'general engineering' courses enjoy greater success as executives than those from specialized curricula?"

Your committee assigned certain items in the above program to its members. When the material had been submitted, a meeting was held to discuss the information provided and the experience of members in administering courses in personnel. The name of the author is attached to each section of the report where the contribution was individual.

Item "a"

The committee has considered the above outline, and submits the following bibliography of books and magazines on personnel administration which it is useful for those giving personnel instruction to have for reference. It includes much more material than would be assigned for outside reading in the usual semester course. It is arranged according to topics, and references especially recommended are indicated by "†." Those next in importance are indicated by "*." Other references will be found helpful in case special subjects are to be investigated or where the seminar method is used. The list is as follows:

General Reading in Personnel Administration

Arranged by Topics

Professor J. W. Roe

Ways of Affecting Behavior in Industry

Title	*Author*	*Publisher*
The Mind in the Making	Harper Bros., New York	James Harvey Robinson
†The Normal Mind	D. Appleton & Co., N. Y.	William Burnham
Psychology of Insanity	G. P. Putnam's Sons, N. Y.	Bernard Hart
Influencing Men in Business	Ronald Press, New York	Walter Dill Scott
Why Men Fight	Century Co., New York	Bertrand A. W. Russell
*Instincts in Industry	Houghton, Mifflin Co., N. Y.	Ordway Tead
The Causes of Industrial Unrest	Harper Bros., N. Y.	John A. Fitch
Labor Economics	Henry Holt & Co., N. Y.	Solomon Blum
Industrial Democracy	Longmans Green, N. Y.	Beatrice and Sidney Webb
†Influencing Human Behavior	Norton & Co., N. Y.	H. A. Overstreet
Psychology	Norton & Co., N. Y.	Everitt Dean Martin
Behaviorism	Norton & Co., N. Y.	John Watson
The Instinct of the Herd in Peace and War	The Macmillan Co., New York	W. Trotter
Why We Behave Like Human Beings	Harper Bros., N. Y.	George Evans Dorsey
Psychology—Briefer Course	Henry Holt & Co., N. Y.	William James
Applied Psychology	D. Appleton & Co.	H. L. Hollingood, A. T. Poffenberger
Psychology for Executives	Harper Bros., N. Y.	Elliot Dunlop Smith

Recruiting, Selection and Turnover

Title	*Publisher*	*Author*
†Selecting Employees, Report of Committee on Employment Plans, Earl B. Morgan Chairman	American Mgt. Assn.	
†Employment Psychology (Part I and Part IV)	Macmillan, New York	Henry C. Link
Vocational Psychology	D. Appleton, New York	H. L. Hollingworth
Manual of Mental and Physical Tests	Warwick and York, Baltimore, Md.	C. M. Whipple
*The Turnover of Factory Labor (Chap. XIV, pp. 281–325)	D. Appleton, N. Y.	Sumner Slichter
*Procedures in Employment Psychology	Shaw, New York	W. V. Bingham, Max Freyd
†Personnel Administration (pp. 41–46)	McGraw-Hill, N. Y.	Tead & Metcalf
†Personnel Management (pp. 76–123)	A. W. Shaw, New York	Scott & Clothier

Placement and Training

†The Instructor, The Man and The Job	Lippincott Co., Philadelphia, Pa.	C. R. Allen
†Education and Industry	Macmillan, New York	Henry C. Link
*Democracy and Education	Macmillan, New York	John Dewey
Training the Industrial Worker (pp. 101–122)	Ronald Press, N. Y.	Roy W. Kelley
†Personnel Administration	McGraw-Hill, N. Y.	Tead & Metcalf (pp. 170–188)
†Personnel Management	A. W. Shaw, N. Y.	Scott & Clothier (pp. 373–394)

Transfer, Promotion and Rating

Title	*Publisher*	*Author*
†Tead & Metcalf	Scott & Clothier (pp. 161–169)	
Annals of the American Academy of Political and Social Science, May, 1916		
*The Turnover of Factory Labor (pp. 290–292 and 355–362)	Appleton, N. Y.	Sumner Slichter
Methods of Transfer and Promotion of Business Organizations	American Management Assn., N. Y.	Survey Report No. 8
†Employment Psychology	Macmillan, New York	Henry C. Link
The Three Position Plan of Promotion		Frank B. Gilbreth
Vocational Psychology (Chapters VI and VIII)	Appleton, N. Y.	R. L. Hollingworth
Psychology of Selecting Men	McGraw-Hill, N. Y.	Donald Laird
*Procedures in Employment Psychology	A. W. Shaw, New York	W. V. Bingham, Max Freyd

Wages

Tead & Metcalf
(pp. 327–344)

The Causes of Industrial Unrest Chapter IV)	Harpers, New York	John A. Fitch
Quarterly Journal of Economics—A Theory of the Rate of Wages, August, 1922		Walter H. Hamilton
Annals: American Academy of Pol. and Social Science, March, 1922—		

Title	*Publisher*	*Author*
Basis for Determining Wage Rates		R. W. Hudson
Practical Experience with Profit Sharing in Industrial Establishments (Research Report No. 29), June, 1920		National Industrial Conference Board
Profit Sharing (Its Principles and Practices)	Harpers, New York	Barritt, Tennison, Gay, Hoilman, Kendall
U. S. Bureau of Labor Statistics—Profit Sharing in the U. S., December, 1916		Boris Emmet
Management Handbook	Ronald Press	L. P. Alford
Principles of Industrial Organization		D. S. Kimball

Job Analysis

Tead & Metcalf
(pp. 251–280)
Scott & Clothier
(pp. 133–160)

†Employment Psychology (Chap. on Job Analysis), pp. 251–269	The Macmillan Co., N. Y.	H. C. Link
Management and Administration Wage Scales with a Reason, Issue of May, 1925		Merrill R. Lott
*Problems in Personnel Mgt. Job Analysis and Job Specifications	H. W. Wilson Co., N. Y.	Daniel Bloomfield
Hiring the Workers, Analyzing the Job, pp. 45–56	Engineering Magazine Co.	R. W. Kelly

Production Incentives

Title	*Publisher*	*Author*
*Administration of Industrial Enterprises (Chaps. XII, XIII, XIV)	Longmans Green, N. Y.	E. D. Jones
*Journal of American Society of Engineers—Non-financial Incentives, Dec., 1918, New York		Robert B. Wolf
The Works Manager Today		
Payment by Results Chapters V, VI	Longmans Green, London	Sidney Webb
Industrial Management (Sept., 1920), pp. 210–217—New York		
Comparison of Wage Incentive Systems and the 100 Per Cent Time Premium		L. V. Estes
A Management Viewpoint on Extra Incentive Wage Plans, American Management Pamphlet Series No. 7, New York		Frank P. Cox
Principles of Industrial Engineering—Chapters VII and VII, New York		Chas. B. Coing
Creative Impulse in Industry	Dutton, New York	Helen Marot
Bulletin of the Taylor Society Premium and Bonus Plans—April, 1923, p. 59		H. K. Hathaway
New York Financial Incentives—June, 1927, p. 425		E. D. Smith

Employee Representations

Tead & Metcalf
(pp. 407–445)

Title	*Publisher*	*Author*
†Education and Industry (pp. 198–212)	Macmillan, New York	H. C. Link
Pamphlet of American Association:		
Some Major Aspects of Employee Representation (Prod. Exec. Series No. 33, 1926)		
Employee Representation Technique (Prod. Exec. Series No. 49, 1926)		Henry G. Metcalf
†The New Leadership in Industry (Chaps. VI and VII)	Dutton, New York	Sam A. Lewisohn
Political and Industrial Democracy (Chaps. VII and VIII)	Funk & Wagnalls, N. Y.	W. Jett Lauck
The Shop Committee	Macmillan, N. Y.	W. S. Stoddard
Annals of American Academy of Political and Social Science:		
Representation in Industry (Vol. 81, pp. 167–181, Jan., 1919)		John D. Rockefeller, Jr.
Employee Representation (Vol. 103, pp. 34–39, Sept., 1923)		W. G. Merritt
Representative Government in Industry	Doran, N. Y.	J. Meyers
When Workmen Help You Manage (Chap. VI)	Century Co., N. Y.	W. R. Bassett
†Employee Representation (Human Relations Series No. 5)	Williams & Wilkins, Baltimore	H. R. Burton

Supervisory Development

Tead & Metcalf

(pp. 135–152)

Title	*Publisher*	*Author*
†The Foreman and His Job	J. B. Lippincott Co., Philadelphia, Pa.	Charles R. Allen
†The New Leadership in Industry (Chap. IV)	E. P. Dutton, New York	Sam A. Lewisohn
The Works Manager Today	Longmans Green & Co., London	Sidney Webb
Foremanship and Supervision	John Wiley & Sons, N. Y.	Frank Cushman
Developing Executive Ability	Ronald Press, N. Y.	E. B. Gowin
*The Technique of Executive Control	McGraw-Hill, N. Y.	E. H. Schell
†Education and Industry (Chap. X, pp. 188–209; Chap. XI, pp. 177–197)	Macmillan, N. Y.	Henry C. Link
The Nature and Uses of Creative Leadership	Bulletin of Taylor Soc., N. Y., June, '27	Ordway Tead
Development of Foremen (Prod. Exec's. Series No. 14)	American Management Assn., N. Y., 1926	Frank P. Cox, Russell N. Keppel
The Practical Aspects of Foremen Training	Industrial Management, Dec., 1927, pp. 363–367	Arthur F. Dodge

Health, Sanitation and Accident Control

Tead & Metcalf
(pp. 84–108)

Title	*Publisher*	*Author*
*Labor Maintenance (Chaps. 12, 13, 14 17)	Ronald Press, N. Y.	Daniel Bloomfield
Health Service in Industry	Macmillan Co., N. Y.	W. I. Clark
Industrial Management—July, 1921		E. B. Morgan
Health Service Side of Personnel Arrangement		S. J. Repplier
National Industrial Conference Board Special Report No. 22, 1922.) The Physician in Industry.		
Monthly Labor Review—Sept., 1920, pp. 549–550	U. S. Bureau of Labor Statistics	
Necessary Qualifications and Activities of an Industrial Physician.		
Mental Hygiene of Industry (Engineering Foundation of Reprint Series No. 1)	United Eng. Societies, New York, 1920.	
Mental Causes of Accidents	Houghton Mifflin Co., N. Y.	B. Fisher
Cost of Industrial Accidents, pp. 831–843	U. S. Bureau of Labor Statistics, April, 1920	
Principles and Practices of Safety. National Safety Council, Chicago, 1919		

Title	*Publisher*	*Author*
Fatigue Study	Macmillan Co., N. Y.	F. B. & L. M. Gilbreth
Mind and Work, pp. 3–35; 39–82	Putnam, N. Y.	C. S. Myers
Fatigue and Efficiency (Russell Sage Foundation)	Chartes' Pub. Co.	Josephine Goldmark
American Management Association Report (Annual Convention Series No. 19). Manual of Health Supervision.		R. S. Quimby
The Nation's Health (Articles in Issues of December, 1926, January and March, 1927)		Cassius H. Watson
The Safety Man in Industry, No. 84 Series of Safe Practices Pamphlets	National Safety Council, Chicago, Ill.	
*National Safety News, September, 1928—"Safety for the Body; Adventure for the Mind"		Glenn Frank

Employee Providence

*Labor Maintenance, pp. 339–356, 357–368, 369–398	Ronald Press, N. Y.	D. Bloomfield
*How to Get Ahead Financially	Harper, N. Y.	W. A. Schnedler
Industrial Pension Report of the Merchants Association of New York (1920)		
Pensions for Industrial and Commercial Employees (Amer. Management Assn., 1922)		

Title	*Publisher*	*Author*
*Retirement Plans in Industry (New York Times Annalist), Nov. 20, 27 and Dec. 4, 1925		Curden Edwards
Financing Pension Plans (American Management Assn., 1926), Financial Executive's Series No. 19)		Joseph H. Woodward
*Pensions: A Problem of Management (American Management Assn., 1928)		E. S. Cowdrick
Experience with Mutual Benefit Associations in the United States (National Industrial Conference Board), Res. Report No. 65		
Principles of Labor Legislation, pp. 409–414	Harper, N. Y.	J. R. Commons, J. B. Andrews
Employee Insurance, National Ass'n of Corp. Training, Confidential Report No. 7—1921		
Monthly Labor Review, July, 1927	Bureau of Labor Statistics.	
Establishment Funds for the Benefit of Disabled Workers, pp. 20–26		
Why Workers Borrow: A Study of Credit Unions, pp. 6–16.		

Title	*Publisher*	*Author*
Unemployment Insurance in Theory and Practice (National Industrial Conference Board), Research Report No. 51—1922	Century Company	
Digest of Workmen's Compensation Laws of the U. S. and Territories (Workmen's Compensation Publicity Bureau)—1921		F. R. Jones
Workmen's Compensation Acts in the United States (National Ind. Conf. Bd.) Research Report No. 61—1923		
†		Tead & Metcalf (pp. 361–375)
The Building and Loan Association	John Wiley & Sons, N. Y.	Robert Siegel, J. Russel Doubman
Employee Stock Purchase Plans in U. S. Industrial Group Insurance, May, 1927	(Nat. Ind. Conf. Bd.)	
The Service Letter on Industrial Relations, Dec. 5, 1928 (Nat. Ind. Conf. Bd.), The Operation of Credit Unions		
Bulletin No. 458 of the U. S. Bureau of Labor Statistics, Feb., 1928, Chapters II, VII, VIII, X		

Recreational and Social Activities, Miscellaneous Service

Title	*Publisher*	*Author*
The Administration of Industrial Enterprises, pp. 300–322	Longmans Green Co., N. Y.	F. D. Jones
*American Management Association Pamphlets		
Convention Address Series		
No. 7, Tuning the Employee Publication into the Personnel Program		
No. 9, Housing Employees		
Annual Convention Series—1926		
No. 15, Employees Lunchrooms		
No. 34, Credit unions—Their Operations and Values		
No. 44, Costs of Representative Employee Magazines		
No. 45, Building and Loan Associations		
No. 46, Vocation Principles and Practices for Persons of Responsibility		
Vacations for Industrial Workers	Ronald, N. Y.	Charles M. Mills
The Works Manager Today, pp. 130–152	Longmans Green, N. Y.	Sidney Webb
U. S. Bur. of Housing and Transportation (Report of U. S. Housing Corp.—Government Printing Office, 1919)		

Title	*Publisher*	*Author*

nce, 1919)

Title	*Publisher*	*Author*
Vocational Education Magazines, pp. 337–341	Philadelphia	H. C. Link
Employment Methods (Chapter XXX —Appendix D)	Ronald, N. Y.	Nathan Shefferman
National Industrial Conference Board Service Letter, August 5, 1928		
Summary of National Industrial Conference Board Report Industrial Lunch Rooms, 1928		
National Industrial Conference Board Service Letter, October 5, 1928		
The Company Store, Page 3		
Bulletin No. 458 of the U. S. Bureau of Labor Statistics, February, 1928, Chaps. III, IV, V, VI, IX, XII		

Item "b"

The committee was asked to "recommend a small list of books to be read by all engineering students." The following list is representative and will present to the student the major subjects in personnel administration. Other lists can be made up to suit the judgment of the teacher or the special needs of the department by selecting from the bibliography submitted under item "a." If the list below is considered too long, selections can be made from it to meet the needs of a department.

Short List of Books

Title	*Publisher*	*Author*
Personnel Administration	McGraw-Hill, New York	Tead & Metcalf
Personnel Management	Shaw, Chicago	Scott & Clothier
Employment Psychology	Macmillan, New York	Henry C. Link
Education and Industry	Macmillan, New York	Henry C. Link
Labor Management	Shaw, Chicago	G. S. Watkins
The New Leadership in Industry	Dutton, New York	Sam A. Lewisohn
Bulletins	American Management Association	
Influencing Human Behavior	Norton & Co., New York	H. A. Overstreet
Harvard Business Report, Vol. IV	Shaw, Chicago	G. S. Watkins
The Normal Mind	D. Appleton & Co., New York	William Burnham
Selecting Employees	American Mgt. Assn. Report of Committee on Employment Plans, Earl B. Morgan, Chr.	
The Instructor, The Man and The Job	Lippincott Co., Phila., Pa.	C. R. Allen
The Turnover of Factory Labor	Appleton, New York	Sumner Slichter
The Control of Wages	Foran, New York	Walton, Hamilton, May
Introduction to the Study of Labor Problems	Crowell, New York	Gordon S. Watkins
Employee Representation	Williams & Wilkins, Baltimore	H. R. Burton
The Foreman and His Job	J. B. Lippincott Co., Phila.	Charles R. Allen
Problems in Industrial Management, pp. 235–342	Shaw, Chicago	Schell & Thurlby
Labor Maintenance	Ronald Press, New York	Daniel Bloomfield
Non Financial Incentives	Transactions of the A. S. M. E., Volume 40, p. 925	By R. B. Wolf

Item "c"

"Make a recommendation as to amount and character of personnel instruction desirable for various groups of students." If we consider a course of two or three semester hours to be required of all engineering students or to be made elective for all, it seems desirable to attempt the following:

1. Show the place of functionalized personnel work in industrial organization.
2. Show the importance of using farsighted and scientific methods.
3. Explain the methods which have proven successful under various conditions.
4. Present sources of detailed information available for further study of specific personnel problems.

The opinion of the committee was that the course should be prepared for engineering students in general rather than to attempt to formulate a separate curriculum for each particular branch of engineering. After due consideration, the following plans are recommended: The first is the curriculum which has been followed for the past eight years at Sibley School of Mechanical Engineering, Cornell University, and the second is a proposed curriculum for the engineering students at Purdue University.

Dean Kimball makes the following statement concerning the course given at Cornell University:

"We give a regular course in Industrial Relations which is required of all students in the Industrial Engineering option, and in this course considerable attention is given to personnel work. We have felt that an entire course in personnel work is not necessary or desirable for engineering students, but that a course on industrial relations in general is necessary.

"This instruction is supplemented by lecturers from industry. Thus we have just had both Mr. Lewisohn and Mr. Alford as outside lecturers.

"In other words, we treat this exactly as we would any other topic and we do not believe that any special mechanisms are necessary."

Outline of Course in Industrial Relations

By J. R. Bangs, Jr., Assistant Professor Industrial Engineering
Sibley School of Mechanical Engineering, Cornell University

"Prerequisite: Industrial historical background and industrial organization.

"A two-hour recitation course running for one term, known as Industrial Relations, is required of all Seniors taking the Industrial Engineering Option. The course is open as an elective to other options. Approximately 90 students will register in such a course.

"Text: Personnel Administration, by Tead and Metcalf. Personnel Administration Reference Texts. Scott and Clothier, Personnel Management, John Leitch, Man to Man; Franklin and Fleisher, The Human Factor in Industry; Kimball, Principles of Industrial Organization, Alford, Managements Handbook.

"Case Material: Harvard Business Reports No. 4 and material gathered by the faculty members during the summer. Such material covers a survey of such plants as the Western Electric at Kearny and Hawthorne, Westinghouse Electric and Mfg. Co. at East Pittsburgh, the General Electric Co. at Schenectady and Lynn, and such smaller companies as the Gleason Works at Rochester, Corona Typewriter Co. at Croton and Syracuse, and the Willys Morrow Co., at Elmira.

"This course parallels other courses in factory planning and layout, production control, Industrial Accounting, Cost Accounting and Corporation Finance, and all personnel problems arising from the various sources are carefully coordinated.

The major points covered are:

(1) The personnel Department and its relation to the rest of the organization.
(2) The technique of Employment Methods.
(3) Methods of selection—a detailed study of the known methods of selecting personnel. This represents a

study of the methods used by large and progressive industries, such as the General Electric, Bell System, Westinghouse, Western Electric, etc.

(4) Studies in Industrial Education, Health, Safety and Fire Protection.

(5) Studies in Job Analysis and Job Specification.

(6) The performance of actual time studies, in our shops on practical workmen, working under practical conditions. The approach and personnel factor is strongly stressed.

(7) A detail study and plotting of representative wage systems as per attached sample problem.

(8) Joint relations involving employee representation, the collective agreement employers association, industrial councils, etc.

"CORNELL UNIVERSITY,
"SIBLEY SCHOOL OF M. E.

"Dept. of INDUSTRIAL ENGINEERING Course 386. 2 Credits.
First Term, 1928–'29

"Problem on Wage Systems

"A survey of the industrial situation of the manufacturing town of Larson, Michigan, disclosed the following data concerning its wage payment plans in the steel castings industries:

"I. *Wage Payment Plans in Operation.*

(*a*) Straight Day Rate (hourly rate, $.50 per hr.)

(*b*) Straight Piece Rate

(*c*) 100 per cent Time Premium Plan

(*d*) 50 per cent Halsey Premium Plan

(*e*) Bedeaux Point System (a 3/4 Halsey system)

(*f*) Rowan Plan

(*g*) Gantt Task and Bonus Plan { low rate, $.50 per hr. / high rate 1 1/3 × low rate

(*h*) Emerson Efficiency Plan (see table, page 225, Kimball)

(*i*) Taylor Differential Piece Rate Plan. (Low rate, 2/3 of high rate. High rate starts at 160 pieces.) *References, Kimball; and Management's Hand Book.*

"II. The 8-hour day is used throughout the town and the average maximum production in the steel castings industry (on a typical operation in the drilling Dept.) is 160 pieces in 8 hours.

"III. In order to pay the average good man the same under any system it was recommended that $5.33 be paid for 160 pieces in 8 hours under any of the systems.

"IV. *Class Problem*

(*a*) Write an elgebraic expression for each wage system, using the following notation:

S = Std. time
T = Time taken
R = Base rate per hour
r = rate per piece
N = number of pieces in 8 hrs.
s = Std. time per piece

(*b*) Give sample computations for each system on this basis, that by any system a man must be paid $5.33 for 160 pieces in 8 hours.

(*c*) Plot curves for each system, calculating 2 or more points for each system, using one sheet of $10'' \times 15''$ cross section paper. (10 of smallest divisions on paper $= 1/2''$.)

Coordinates { Abscissæ—No. of pieces in 8 hrs.
Ordinates—Wages for 8 hrs.

(*d*) Tabulate—advantages and disadvantages for each system."

Table of Contents of Course in Industrial Personnel Administration for Students of Engineering.

3 credits.

By J. E. Walters,

Director of Personnel, Schools of Engineering, Purdue University, Lafayette, Indiana

1. Introduction
   - I. Purposes and Field of Personnel Administration
   - II. Industrial Historical Background
2. III. The Personnel Department

3. EMPLOYMENT
   - IV. Labor Supply, Employment Methods and Tests
   - V. Promotions, Transfers and Regularizations
   - VI. Discharge, Retiring, Rehiring and Research

4. LABOR MAINTENANCE
   - VII. Wages and Rewards
   - VIII. Job Specifications and Job Analysis
   - IX. Joint Relations, Shop Rules, and Regulations Labor Unions and Employers' Organizations
   - X. Labor Turnover and Labor Audit
   - XI. Personnel Records

5. XII. INDUSTRIAL TRAINING AND EDUCATION
6. XIII. HEALTH
7. XIV. SAFETY
8. XV. EMPLOYEE SERVICE WORK

It was suggested that the committee recommend a suitable text or texts for teaching personnel administration in the colleges. The committee agreed that there were no texts that fulfilled such a need, but that the best ones to be had at the present time were:

1. "Personnel Administration," by Tead and Metcalf—McGraw-Hill Company—for fundamentals of the subject.

2. "Personal Management," by Scott and Clothier—A. W. Shaw Company—for technique of the subject.

3. "Labor Management," by Watkins—A. W. Shaw Company.

4. "Harvard Business Reports," Vol. IV—A. W. Shaw Company.

It was further pointed out that all instruction should be adequately supplemented by suitable case material, either as given under "4" or as developed by the faculty member in charge of the course.

The above outlines meet the needs of electrical and mechanical engineering students best, and are least valuable to the civil engineering student, who is more concerned with problems of construction than with those of factory production. A course is being prepared which is built on the material

regularly given by the department of industrial engineering of The Pennsylvania State College to those in other engineering courses with applications especially to the problems of the civil engineer. This material will be available as soon as experience has proven its merits.

Item "d"

"What is the relative efficacy of formal courses, seminars, etc., in personal instruction?"

Professor Roe says on this subject, "The conference method on an informal and objective basis has proven best. Active discussion has been stimulated and constant reference is being made to the experiences of the students in various organizations where they are working. This has made the work of the course vivid and real."

Professor Beese uses the recitation method with outside reading assignments followed by written outlines. The "case" method is used during the last few weeks of the course, a list of source material being supplied to the class.

The committee felt that the method of conducting a course in personnel administration depended a great deal upon the person giving the course.

In general, when installing a new course the lecture method or the recitation-discussion method is the simpler. Fundamentals and background should be developed first and then specific applications in the form of "case" material may be used to test the student's knowledge and to develop his interest to a higher degree. Instructors of considerable industrial experience are able to dramatize their material in such a way as to make the seminar method of instruction highly desirable.

Item "e"

"If feasible, collect "case" material for use in personnel instruction and make same commercially available." With regard to item "*e*," the committee agreed that at the outset the teacher should use available case material. Harvard Business Reports, Vol. IV, are excellent for this purpose. As

the experience in teaching increases, the faculty member should collect cases of his own and should build them into the course. As such case material develops, the committee recommends that it be submitted with the proper description of the industrial conditions surrounding it to a *clearing house committee or agency* who might pass it on to the teaching profession interested should it have the proper teaching and personnel merit. The committee recommends that such committee or agency be appointed or set up by the S. P. E. E.

The following was submitted by Professor J. W. Hallock:

Case Material for Use in Personnel Instruction

"The letter of appointment of the committee of personnel instruction, dated December 28th, suggests that the committee collect case material for use in personnel instruction and make same commercially available.

"It is my opinion that the average course in personnel instruction is built up along entirely too narrow lines. Instead of treating subjects relating to industrial labor from the very narrow viewpoint of methods used in securing, training and retaining personnel in industry, my conception of the proper content of such a course is the broad one of labor problems. There is a certain historical background to the whole subject. If we are to teach the subject merely as the mechanics involved in hiring and firing men the case material is extremely important. If, however, we are to consider such broad topics as those followed by Professor Watkins in his text "Introduction to the Study of Labor Problems," then there is relatively little need for extensive case treatment.

"On the other hand there are already available a number of sources of case material already adapted to use in the teaching of personnel administration. Some of these are listed below:

1. Problems in Industrial Management—Schell and Thurlby, A. W. Shaw Company. Section five of this book covering pages 235 to 342 gives 33 sample cases without solution but with excellent textbook references.

2. U. S. Bureau of Labor Statistics: Decisions of Courts Effecting Labor; Labor Laws of U. S.; Labor Legislation.
3. National Industrial Conference Board. A number of books on such subjects as, Employment of Young Persons, Industrial Pensions, Wages and Working Hours.
4. The Annals of the American Academy of Political and Social Science (Vol. 65, May, 1916). An excellent discussion showing a number of important phases by men in various industries.

"In addition to the above, valuable statistics and facts relating to labor may be obtained from the American Labor Yearbook and the American Labor Press Directory.

"Excellent case material should also be available through engineering schools using the cooperative plan and from college personnel officers who are in touch with Alumni from their respective institutions.

"Dr. Bishop's original letter of appointment would seem to indicate that he conceives it to be a proper function of this committee to obtain and edit case material for use in teaching personnel work. It is my personal opinion that this is a task of such magnitude as to deserve extremely careful study before undertaking even the construction of a bibliography on the subject.

"To answer specifically the questions set forth in Dean Sackett's letter of March 29, I might state that only students in Industrial Engineering at the University of Pittsburgh are required to take courses in personnel administration. The course is elective to students from other engineering departments. The text book used is "Personnel Administration" by Tead and Metcalf. Outside speakers are frequently called in for the discussion of special topics.

"We do not feel that the same amount of detailed instruction is required because our students do cooperative work in the industries and thereby acquire first-hand information on many of the points necessarily taught elsewhere by formal classroom instruction."

Item "f"

"What can be done specifically during a college course to develop 'personality' in students?"

Mr. Walters presented the method of developing personality used in the Schools of Engineering at Purdue University, and Dean Ayer presented the procedures used at the University of Akron. Following a discussion of these plans, the Chairman delegated Mr. Walters to prepare a condensed report of the Purdue plan to be known as a comprehensive system on personality development, and Dean Ayer to prepare a report on a simple or modified comprehensive plan of personality development for the consideration and approval of the committee.

It was strongly pointed out that such systems of personality development must be operated by *intention* and not be left to the individual desires of the students and faculty members.

The following are the two final plans which have been approved and are recommended by the committee:

Simple or Modified Comprehensive Plan of Personality Development

Dean Fred E. Ayer

"While the committee feels that a comprehensive plan similar to the one in use at Purdue University is highly desirable, yet it realizes that many institutions will hesitate to adopt a program of such extent. That the development of personality is highly desirable, none will deny, and that some progress in such development during the time spent in college is possible seems a goal not at all attainable. Therefore, the following plan is suggested in the hope that every engineering college will find it possible to do something of personality development without adding to its present staff or budget.

"1. Some one person should be delegated to take charge of the work, preferably at the outset, the dean, but if he has not the time, he should appoint a faculty member who is interested in the work, and what is more important, one who is keenly

and sympathetically interested in the students. The committee is unanimous in the belief that one-man responsibility is absolutely essential to the success of the plan.

"2. Adopt a simple rating sheet which will discover at least two things, the outstanding strength and the gravest weakness of each student rated. It may be possible to accomplish this result without a rating sheet which lists definite characteristics by calling upon each one making the rating to give what, in his opinion, are the strongest and weakest traits of the student under consideration.

"3. Select at least five persons, preferably more, who are acquainted with different phases of the student's activities. The parents ought to furnish valuable information.

"4. Select as many students in the first or second year class as can be rated without sacrificing too much time belonging to other work.

"5. From the group rated, choose only as many as the personnel officer can manage with thoroughness. A dozen students properly handled will produce far better results, both in benefits to the individual students and in demonstrating the possibilities of the work, than three or four times that number followed up inadequately.

"6. The personnel officer should tactfully interview each student selected, and endeavor to gain his confidence. It is hinted that a mention of his strength and the possibilities of success through its further development is usually a better approach than a criticism of his weakness.

"7. The personnel officer should next enlist the interests of everyone who has any contact with such student and secure their cooperation in helping the student to profit by his advantageous characteristics and in aiding him to overcome his weak ones.

"In following this simple plan, it is not necessary to select big and glaring faults to correct, but, on the contrary, simple and seemingly harmless ones may offer the easiest approach to the winning of the student's confidence. For example, a student may be making a very poor impression upon his instructors by reason of reciting in a low tone with poor and

slovenly enunciation, or because of carelessness in his dress, procrastination, lack of punctuality, proneness to argue over inconsequential details, and dozens of other little idiosyncrasies which he can easily correct. If he has these faults brought home to him from sources varying all the way from his dean to his sweetheart, he will eventually awaken to the desirability of eradicating them.

"In this age of mechanical power and subdivision of labor personality is such an important factor in success that the least that we instructors can do in helping to develop it is bound to produce some results."

A Comprehensive System for the Adjustment of Personality of Engineering Students

Director J. E. Walters

"The proper development of the mind, body, character, and personality, is essential to insure complete success to the student in college and after graduation. Each of these phases of development has an effect upon the others. They are interrelated. They cannot be considered alone, yet the mind, the body, the character, and the personality, should each have its special and separate development by intention and not be left to take care of itself.

"Mental development comes through instruction and the other academic activities, and its status is indicated by the grades received. Physical development comes through adequate regular exercise, proper food, fresh air, and sufficient rest and can be judged by periodical physical examinations. Moral development is assisted by religious organizations and general environment, and is judged by the student's truthfulness, honesty, and associates. Social development, that of the personality, is usually left for the student to take care of himself, except where a personnel or similar service exists. As a student develops a mathematical formula by intentional study, so he or the college should develop his personality by studying it and working out the difficulties by intention.

"Character and personality are similar yet distinct. Char-

acter is the sum of one's moral characteristics, and personality is the sum of one's social traits. Character involves right and wrong. Personality is the sum of one's traits which cannot necessarily be distinguished as right or wrong. Honesty and truthfulness are characteristics of a good character because it is wrong to be dishonest or untruthful. Initiative is a trait of personality because it is not necessarily right or wrong to lack initiative. Many students have good characters but poor personalities. Some students have fine minds but poor personalities; others have fine physiques but poor personalities.

"A good personality is one of the major requirements exacted by employers of college seniors and an important qualification for success. The engineer, no matter how well he may know how to construct bridges, must first come into contact with others and secure a contract for a bridge before he can build it.

"From selfish viewpoints, the college should want its students to have the best personalities to reflect properly on the college, the student should want a good personality in order to achieve the most, and the industrial concerns should want its employees to have better personalities so that they will make larger profits and show the company at its best.

"A good personality comes from proper social development. 'Social' is derived from the Latin word 'socalis,' and means 'of or pertaining to mutual relationship with others.' Personality then depends upon activity with others for its existence; otherwise it is lost, whether good or bad. It is judged by the manner in which it affects other people.

"It is difficult for a student to see himself as others see him, to know his faults and his good traits; yet without a knowledge of them he may be greatly handicapped. Therefore, the college, having students during an important formative period of their lives, should strive to correct their faults and to guide them in the proper use of their good traits.

"As in some mathematical problems certain assumptions are made and then proved to be true, so let us approach personality development with the following assumption and try to prove that it can be done in that way.

"Personality, the sum of one's social traits, is based mainly on habit. A trait of personality is a habit system, a bundle of habits. It is developed or changed in the same manner in which a habit is developed or changed, provided there is no physical or other inherent hindrance. Industriousness, a trait of personality, is working hard habitually, using one's time effectively in all situations. A trait is affected greatly by environment, and is very specific. A student may be industrious at his fraternity house and lazy at home. Laziness is judged by most of the situations involved. If a student is industrious in but very few situations, he may be considered on the borderline of laziness. If he is industrious in half of his situations, he is average in industriousness; but if he is industrious in all of his situations, he is high in industriousness. He has the habit of being industrious.

"A trait of personality, a social habit system, involves the highest level of consciousness but is composed of many lowest level habit units, that of the impulse crossing from one nerve cell through the synapse (the place where the connections of that nerve cell and the next one come into contact or close together) to the next neurone. The impulse then goes through the next synapse, and the next and so on, traveling to the spinal cord, the mid-brain, the brain-proper; is perceived; and is sent out in the form of a reaction which, in the case of industriousness, is 'the beginning to work,' or in the case of laziness, 'to loaf.' If the same stimulus is received a second time, it will be easier for the impulse to pass through the same path as before because that path is made larger, less resistant by use. And, so on, by reuse, the habit path is formed and the same reaction occurs which in industriousness is 'to work.' This is particularly true if each reaction results in a satisfactory situation, such as a reward for being industrious.

"If a bad habit path is formed, such as laziness, a good habit path must be started through strong desire and effort, usually resulting in a pleasing situation. Then, by reuse, that good habit path becomes larger until it is practically nonresistant, and the bad habit path becomes smaller and smaller, by the theory of disuse.

"A great difficulty is that the student will not keep at the good habit long enough for it to become firmly formed, and for the old bad one to disappear. The latter statement should be particularly emphasized to the students. Also, a trait of personality involves many thousand lowest level units; hence the difficulty of personality development caused by the facilities of many different paths which might be taken. With these assumptions, we need a technique for the determination of personality and for the development of it.

"As the Personnel Service of the School of Engineering at Purdue University has had a definite comprehensive procedure for the development of the personalities of its students since 1921, a description of that technique, based upon the above assumptions concerning the nature of personality, may prove of value to other colleges.

"Before the freshman arrives at Purdue University, he is expected to fill out complete personnel information about himself, with a self-analysis of his personality which is intended to focus his attention, from the beginning, on the development of his personality, and to give the college an idea of what he thinks of his own personality.

"In the middle of the first year, reference and personnel blanks are filled out by each freshman. He gives the names of fifteen people—five teachers, five students, and five others—who know him. They are asked to rate him on the traits of his personality. A personality rating scale, which is shown herewith and which has been tested statistically and found reliable, is given or sent to each reference for a rating in comparison to other students of a similar age, educational preparation, and environment. As soon as the ratings are returned to the personnel office, they are scored, compiled, averaged, and recorded on the student's personnel record. The general averages are ranked from the lowest to the highest and divided into quarters. All students whose general averages fall in the lowest quarters are invited into the Personnel Office for a conference about the development of their personalities. Each student's personality is discussed with him and methods of improvement are pointed out and *followed up*. The fifteen

references give a fairly reliable rating and cause the student to respect the ratings more than the personal opinion of an advisor. In this plan emphasis is placed on collecting reliable personnel information and particularly upon getting it back to the students for their use.

"Several typical cases showing the technique used were given in the detailed description of the Purdue Personnel Procedures which appeared in the January, 1928, JOURNAL OF ENGINERRING EDUCATION.

"Some students adjust their personalities readily, others (15 per cent at Purdue) with habits deeply formed, or because of physical or inherent reasons, do not.

"A study of the effect of the above described technique of personality development, interviews, and follow-up, in the case of the seniors of the present graduating class of 1929 of Purdue University who were in the lowest quarter of their class in personality ratings, indicates that those students in the lowest quarter who were interviewed many times and followed up in detail, were rated 15 per cent higher in their junior year than in their freshman year; that those who were interviewed once but not followed up were rated 7.5 per cent higher; that those who were not assisted at all, except indirectly, were rated 7.5 per cent higher; and that the entire class had been rated 6 per cent higher.

"The average of those who were interviewed and followed up advanced two and one half times as much as did the average of the entire class and twice as much as those who were not interviewed. Those interviewed once and not followed up did not advance any more than those not assisted at all. The mean rating of those who were interviewed and followed up was raised from the fourth (lowest) quarter of the class in the first year, to the second quarter in the third year, an advance of one half of the class.

"The scholastic mortality of all of those in the lowest quarter of their class in personality ratings was 20 per cent higher than that of the entire class.

"The personality ratings, besides being used for the above procedures, are also valuable for use in vocational and edu-

cational guidance, placement, and other personnel services. The ratings can be used beneficially to encourage students to make better grades in their courses. As personality ratings and grades correlate .636 ± .056 (Class of 1930) the former can be used as an aid in predicting scholarship. The self-ratings and ratings by others correlate practically not at all —.123 ± .066); yet if a student rates himself exceptionally high and others rate him very low, he may have a superiority complex. The ratings can be used to determine other student complexes, and for many other purposes not mentioned above.

"The above data do not give conclusive proof and we cannot claim too much for them; but they do point out methods of further study. However, we do believe, first, that personality, the sum of one's social habit systems, can be developed in a large majority of our engineering students; second, that the procedures described above, as a comprehensive plan for the development of the personalities of engineering students, have sufficient merit to warrant their use in other engineering schools, with local adaptations; third, that a personality development service, by intention, should be made available to all engineering students; and fourth, that that service should be done well, by intention, and be followed up, or not done at all."

Item "g"

"Do graduates from 'general engineering' courses enjoy greater success as executives than those from specialized curricula?" The committee felt that it was not appropriate for it to attempt to answer "g." The subject is controversial and experience is probably lacking from which to obtain the facts necessary to an intelligent discussion of the subject.

Conclusion

Your committee believes that the training of young men who become supervisors or executives in such large proportions justifies the careful consideration of instruction in industrial relations.

Each institution should study its needs and its teaching staff in order that subject matter may suit its purposes and to insure that the instruction is equal to the demands of a rather difficult subject, especially if the students have had little or no experience.

The report gives sufficient references and suggestions so that an effective course or courses in industrial relations can be organized and it is hoped that it will be of service in enlarging the instruction in this important field.

Discussion

Sam A. Lewisohn, Vice-President, Miami Copper Company: There is one thing that has particularly impressed me while cooperating in the program of engineering education in labor relations, that is the great confusion between two different types of academic activities.

One of these activities is the "personnel work" at colleges, which is the securing of jobs for students when they leave college, and improving their personal characteristics in order generally to orient them for life.

It is an interesting effort but it is entirely different from the one upon which a number of you and I have been concentrating attention.

This latter problem which is the one I am discussing is the introduction of courses in labor relations so that the young engineering student may have the background and technique to handle properly his problem of labor administration when he goes into industry and becomes a foreman, superintendent, manager or major executive.

Quite a number of you gentlemen are among those who have agreed with some of us in business that such training is essential.

We have also agreed that the only way of accomplishing this is by devoting a certain amount of time, during the years that engineering students spend at engineering college, to courses that will awaken the students to the importance of the problem and give them some little background in it and

an intelligent and human attitude towards their future responsibilities in this direction.

I have read with a great deal of interest the report prepared by Dean Sackett. It particularly impresses upon me the necessity of analyzing carefully just what you are attempting to do to the young engineering student in this problem of teaching labor administration.

I think that I can discern two separate phases that you are facing, one of which is more a general problem and which I will discuss first, the other more specific and to be discussed later.

There is in the first place the general phase involving the definite teaching of the subject of labor relations in industry.

This phase can be sub-divided into two parts (*a* and *b*).

The first part (*a*) is cultural knowledge which will give the student a background of industrial psychology, the history of labor, the history of trade unionism, and similar socio-economic problems which aid him to appreciate the differences which the rank and file of workers may have in their psychological make-up as compared with that of their superiors.

It may help them to understand that the workers have an inferiority complex which requires a careful approach on the part of the executive.

The second part (*b*) of this same phase of the problem involves the concrete material of the technique of labor administration.

This technique includes such things as the proper methods of employing, placing, training, promoting employees, securing their cooperation through representatives and committees, handling grievances, reducing fatigue, the proper place of a personnel department in the factory, the training of foremen and safety and health progress and other elements.

Naturally only an elementary course can be given which embraces these two parts. There should be at least enough instruction, however, to impress the student with the im-

portance of the subject. He should be made to realize how deserving it is of his attention. A man with such a preparation will not belittle the whole subject and remain unintelligent in his viewpoint.

One manager once turned to me and said, "Oh, Mr. Lewisohn, you people in New York over-emphasize the personnel problem."

I have mentioned this episode before but I repeat it because I hear it said again and again, "Well, the ability to manage men is purely a matter of innate biological traits.

"It is a question of whether a man has personality or not."

The implication seems to be that education and professional training have no value at all.

I will discuss this question of inborn personality, which is the second phase of the problem, in just one minute but I want to make the point here that those traits need to be developed.

A man, such as the one I have just mentioned, may possess an abundance of magnetism and personality yet may bungle his job of handling his labor relations through total neglect of those problems. He is apt to be guilty of such neglect unless at the crucial period during which students are ready to receive impressions he has had impressed upon his importance of his labor problems and the value of knowledge and continued interest in them.

It is during college—when students are really most like wax—that their professional training affects their outlook.

It is unfair to ask industrialists to train such men at 40. They should be trained at 20.

I have made this phase of teaching labor relations and administration the first part of my discussion because I wish to make certain that we distinguish between teaching this subject to the students and that wholly different thing, college personnel work, by which facilities are offered to the students themselves for placing them in jobs and ridding them of certain traits.

At the same time there is a side of the education of a man

to handle labor problems in which the training required merges to some degree with student personnel work.

So-called personality training to improve the student's human contacts, is the second large phase of the subject I wish to discuss. It has an important bearing here because the student's capacity as a leader of men depends upon this art to some degree.

It is a problem which affects not only labor administration but many other sides of the preparation of the engineer for life.

The problem here is that of making the student a good contact man, or to put it more colloquially a "good mixer" with his superiors, with men occupying jobs of the same plane as his own, and with his subordinates.

It is, as I must repeat, somewhat different from the general improvement of his understanding and background.

It is rather a specific course of treatment to make him effective in his handling of labor administration.

In this attempt we face the broader problems of his general ability to cooperate with those with whom he comes in contact in industry.

A point upon which many of you educators have agreed is that this side of the problem is particularly important with engineering students.

In the first place, because they are by reason of their interest in mechanical matters a group naturally not interested in contacts but more interested in cold scientific problems, or as one educator has put it "the mathematical manipulation of precise formulas relating to concrete materials."

That the engineering student is not particularly interested in the art of contact—that is, in being a "good mixer," starts him off with a handicap as far as his later contacts are concerned.

The tendency of his education at college instead of neutralizing his natural disposition tends to accentuate it, because of this intense preoccupation with purely mathematical manipulation of precise formulas.

Now, in some of the opinion compiled in Professor Sack-

ett's report I think I detect a tendency to attempt to meet this problem by a formal training in applied psychology. I have been reading about rating a man's personality and how to improve his personality.

Now it seems to me that it is possibly a mistake to attempt to solve an essentially synthetic problem by analytical methods or to attempt to solve by formal intellectual methods a problem in which the pupil can only learn by doing. It is rather difficult to apply the precise methods with which you approach the problem of the reaction of inanimate matters, to the human field. I think you will probably find that the art of contact must be taught by some other means, possibly by a more social life at the University.

At the same time there may be some slight value to the rating method. My own impression is that to the extent that the attempt is made to teach formally the problem of contact with subordinates an excellent approach is to use the methods described by Professor Smith.

These methods are to cover systematically in the classroom many types of actual situations which come up in a factory between men. To be concrete, for example, a man is asked to give an order to a grouchy but valuable workman. Now the advantage of this sort of education is that it does two vital things at one time—it kills two birds with one stone. Through the course it gives instruction in the actual content of labor administration, while through the method used it gives men a training in how to handle themselves psychologically, that is, in a problem involving clashes of personality.

After reading Dean Sackett's report I am impressed with the fact that the adoption of the right procedure is most complex. I am certain it is unlikely that we can make much progress in the matter unless an intensified study is made under the direction of specialists who are teaching the subject.

Probably the most effective way would be to appoint a Committee of Instructors at engineering schools and perhaps a few outsiders, to study the problem and to employ expert assistance.

This committee could carry on various types of investiga-

tion and prepare a syllabus. The syllabus outline should be based on the thorough intensive research of the ways in which a course on labor relations could fit into the engineering schedule. It should not be a compilation but a detailed outline fitted to an actual hourly schedule. A standard course of this kind based upon study and upon agreement of those who are experts in the field would give the deans and faculties a definite conception of what the subject of "labor relations" includes, how much of it they wanted and how they could adapt it to their program.

I realize that the problem of organizing a course in engineering school is not simple. In the first place you have to get the proper instructor to give integrated courses and in the second place you have to get the cooperation of the instructors in other courses.

There are the same difficulties in connection with the psychological make-up and training of these engineering instructors as there is with the students they turn out.

For, of course, men who have been exclusively devoted to technical aspects of concrete scientific problems develop habits which lead to a certain sales resistance to an understanding of this whole subject.

In the recent strikes at North Carolina it was very interesting to hear as to how lamentably the young engineers had failed in securing the confidence of the men in applying efficiency methods. These young efficiency engineers were referred to as "minute men" and the system was called the "stretch-out" system. Here again we have the old problem of the difficulties of applying scientific management or any management for that matter where the engineer management does not appreciate or understand the human problems involved in labor administration.

I have heard recently an amusing illustration of what unfortunate results ensue from an untrained management. In the recent difficulties in Colorado there was much hullabaloo that most all the trouble was due to the I. W. W. One of the men when questioned as to whether the I. W. W. was the disturbing factor replied—"O h—— no—our superin-

tendents and foremen treated us so badly that the W. C. T. U. could have organized a strike."

In closing, remember that according to Mr. Hammond's latest estimate 69 per cent. of engineering graduates occupy administrative and managerial positions.

In closing my discussion I want to emphasize again the necessity of preparation of an actual course in labor relations because no matter how attractive a personality a man may have he must also have a philosophy, a background, and some understanding of the actual technique of labor administration and the necessity of orderly methods of organizing men.

REPORT OF CONFERENCE ON STUDENT SECTIONS

A conference on Student Sections was held on June 20, 1929, in connection with the annual meeting of the Society. Dean A. A. Potter, Chairman, Committee on Relations with Colleges, A.S.M.E., presided. The program was divided into two subjects:

1. Basis for Recognition of Colleges by the National Engineering Societies

Wm. T. Magruder, A.S.M.E.

I happen to be chairman of a committee having to deal with this subject. Here are four or five or even six cases which came under my observation during the last year.

College No. 1: If you will recognize our Student Branch and let us start a Student Branch Society here we can get all the members of our faculty to belong to your Society.

College No. 2: If you will recognize our Society and our college we can get more money from the church and the Chamber of Commerce.

No. 3: They will tell you they are purposing starting an engineering college.

We have numerous cases of that kind. The oldest man on the faculty got his degree five years ago. Should we recognize him and his students? There *is* only one *member* of that faculty who is a member of any National Society. Shall we recognize *them?*

These are just a few cases, gentlemen. I have a lot of information there if you want the data. Do you not think drawing should be taught in the Department of Chemistry? One of these societies thinks so. What about metallurgy as a branch of Mechanical Engineering, or drawing, or something else of that kind? Surveying is a branch of chemistry, that is, you survey the metals.

You and I have to study this thing and get somebody who

has backbone enough to say, No. The college which has two or three possible members of its faculty as members of any engineering society has a long way to go before it can be recognized as a member of the society.

Again, let me make the subject entirely clear. It fell to my lot to invite the representatives of the Student Branches and Chapters of the National Engineering Societies to attend this meeting this afternoon. I was simply horrified when I secured, from the Secretaries of our National Societies, corrected and up-to-date lists of the membership of the Societies who were in charge of Student Branches.

I found that of the American Society of Mechanical Engineers there were 30 honorary chairmen, out of more than 90 Student Sections, who were not members of the S. P. E. E. Also, 30 of the American Institute of Electrical Engineers who were not members of the S. P. E. E., and only 17 members, be it to their credit, of the American Society of Civil Engineers who are not members of the S. P. E. E. That makes 77 members of engineering who are not members of the S. P. E. E. They are not interested in this Society.

Is it not about time for us to get busy and recognize ourselves, gentlemen?

J. L. Beaver, A.I.E.E.

This is a subject with which each national Engineering Society is struggling. The A. I. E. E. has been working on it actively for the last two years and may be farther from a solution now than ever. We have 103 student branches. They were organized in 1902 at the suggestion of Professor C. F. Scott, who was then president of the A. I. E. E. We have 10 districts in the U. S. A., each headed by a national Vice-President. Each student branch has a faculty adviser who must be an associate, member, or fellow of the A. I. E. E. and whom we call counselor.

The student chairman and counselor from each college in the District which has a student Branch attend a meeting once a year in each Vice-Presidential district, generally at the

time and place of the Regional meeting, for the discussion of branch affairs. The expenses are paid by the National headquarters. One of the counselors is elected as chairman for one year.

On the day preceding the annual Summer Convention, one counselor from each Vice-Presidential District meets at the place of the convention. (Expenses paid by National Headquarters.) This meeting is presided over by the Chairman of the National Committee on Student Branches.

The national Committee on Student Branches consists of five, two of them are generally engineers, and all are appointed by the President, about one new member each year.

Prior to June, 1928, the by-laws of the A. I. E. E. read as follows:

"Any person registered as a full-time student in a university or technical school of recognized standing who is pursuing a regular course of study in preparation for the profession of electrical engineering may be enrolled as a Student of the American Institute of Electrical Engineers. The designation of full-time students is intended to include those who devote either their entire time or the major part of their time to studies. The expression "school of recognized standing," is interpreted as applying to schools of college grade providing an engineering curriculum of not less than *three years, and granting degrees.*"

The above committee met at Annual Convention last June and as a result the following was approved by the Board of Directors in August, 1928.

"Any person registered as a full-time student in a university or technical school of recognized standing who is pursuing a regular course of study in preparation for the profession of electrical engineering may be enrolled as a Student of the American Institute of Electrical Engineers. The designation of full-time students is intended to include those who devote either their entire time or the major part of their time to studies. The expression "university or technical school of recognized standing," is interpreted as applying to any

school of college grade which provides an engineering curriculum and is considered by the Committee on Student Branches to maintain suitable qualifications in entrance requirements, content of curriculum, proficiency of teaching staff, and laboratory equipment."

When a college asks for the establishment of a student branch the request is voted on by the Committee on Student Branches and if the vote is favorable, it is then approved by the Board of Directors.

The Committee on Student Branches acting under Section 51 of the by-laws is influenced by the following considerations:

1. Under the old three-year rule many schools could qualify but when it came to suitable qualifications in entrance requirements, content of curriculum, proficiency of teaching staff, and laboratory equipment, some were sadly lacking. The A. I. E. E. has several such branches, they qualified under the 3-year rule and have a Branch.

2. Under this new rule the Committee on Student Branches has entire authority and it secures catalogs, sometimes makes visits to, and has conversations with, those who know the work of the institution, etc., before making a decision. I can see how the change in personnel in the committee can in a few years possibly change the kind of school which will be admitted.

3. A school which graduates men who normally are qualified for admission to the A. I. E. E. as associates should be allowed to have a Branch unless there is some good reason for denying the request.

I interpret this to mean a school with a two-year course might qualify if it carefully chooses mature men and if these men after graduation take positions leading to real engineering jobs rather than that of electrician, artisan, foreman, etc. The committee has so far accepted no two-year school, though two have applied, but under the present rule it may.

4. The curricula should be long enough to give students a good introduction to A. I. E. E. activities so they can conduct

Branch activities successfully. This would seem to require at least a two-year course.

5. A definite minimum number of students does not seem practicable. The success of a branch depends upon many local conditions. If a college has some one on its faculty sufficiently interested in the A. I. E. E. to be a member and if he thinks conditions are ripe for a branch then I believe if a small group applies it has enough genuine interest to do more effective work than many a larger group. Certainly the smaller the group the more opportunity for each individual to profit by participating in the activities.

6. In principle a school not qualified to have a student branch should not be permitted to have enrolled students.

7. It probably is not desirable to have Student Branches in a distant foreign country, though I see no reason why properly qualified students should not be enrolled from any part of the world.

In student activities two objectives should be kept in mind.

1. The duty of rendering assistance to the engineering profession by the development of young men *regardless* of their possible membership in a national engineering society.

2. The building up of a membership of qualified and progressive engineers and as a corollary to so interest them that they will not drop out of the National Society membership after graduation.

The conferring of these privileges by one of the founder societies has always seemed to me to be a very important matter. It virtually carries with it the seal of approval of the A. I. E. E. and is a recognition of the standing of the institution. It should not be conferred lightly, nor in accordance with any policy which changes frequently; the policy should be prepared definitely, though probably broadly at present, and furthermore, I believe it should be openly stated. We all know that the work of an institution cannot be completely expressed in terms of entrance or graduation credits, number of teachers or other similar statistical points.

What can this meeting do about this problem. Well, several things.

(*a*) Stir up interest in it, think about it, *get informed on it*, and discuss it.

(*b*) Possibly approve some recommendations (but speaking for the A. I. E. E. I have no authority to vote on any resolution which would bind the A. I. E. E.).

(*c*) Each of us can learn what the other national societies are doing.

This last seems to me most important. The most profitable time I have ever spent on this subject was forty minutes listening to Mr. Hartford, Assistant National Secretary of the A. S. M. E., tell what that Society does. We should inculcate the best in the policies of the other National Engineering Societies but I do not believe all our problems are sufficiently common ever to adopt a uniform set of regulations suitable to all the Founder Societies.

I firmly believe the biggest factor in the future growth of any of the National Societies is the Student Branch.

H. P. Hammond, A.S.C.E.

It is stated as the basis for recognition of colleges by the National Engineering Societies that the emphasis is on the word "recognition." When a Society establishes a Student Branch of Chapter, it certainly stamps the institution as a recognized College of Engineering. That privilege ought to be conferred, it seems to me, and has always seemed to me, with the utmost care.

If you ask any Telephone man—and I have done it and the answer has always been the same to me—he would probably say that the problem must always be answered from three standpoints:

First: Why do it at all?

Second: Why do it now?

Third: Why do it this way?

I do not think I ought to discuss either of the first two of those, and I am only going to make one remark on the third.

Having had a rather intensive experience in endeavoring to find some basis of evaluating the work of an institution,

and having seen all of the limitations that are inherent in formal requirements, entrance, for example, graduation requirements, number of faculty members, faculty members who are members of the National Societies and some way of evaluating laboratory facilities and the like, I believe that the basis of recognition will never be complete if it rests merely upon such things as may be formalized in statements of those points.

There is another element in the problem entirely different. It is an intangible one, it is one that I think must be evaluated, that is the quality of the work which the institution does. How to do that definitely and concretely, as Professor Beaver has pointed out, so that it will be a continuing policy from year to year as committees change and as membership changes, is an extremely difficult thing to determine. Yet, I believe it must be done. Probably the first step in that direction is a visit to the institution in question.

Not long ago I heard this point discussed. It was done by correspondence. In one of the letters the correspondent stated that it would be physically impossible to make visits to all of the engineering colleges in existence.

It is not necessary to do that because in a group of 150 or more Engineering Colleges there are a great many concerning which there would be no question whatever in anybody's mind. They could be written on one side of the ledger at once. It is the marginal, or the doubtful, institution, and the worse than doubtful institution, concerning which there is some doubt.

In that case, I think the only thing that can be done is direct observation, not just by one person but by a small committee of visitors. It is done in other professional fields. Assuming that some basis of recognition of an Engineering College is to be worked out and established publicly then I think that must be done in the field of engineering.

George T. Seabury, Secretary, A. S. C. E.: Gentlemen, apparently this is an interesting subject to you otherwise you would not be here at this late hour after so long a session.

However, I did not come here to talk. My specific reason for coming to your meeting today was to hear your ideas on this particular topic. I was interested in other things too, but this was the main topic that brought me here.

I would just like to tell Professor Magruder that I would like to take the place of one of our faculty sponsors who is not a member of your Society. If you will give one of them credit I will be very pleased.

Professor Magruder said this whole subject is nothing but bluff. I do not think it is. It is just a question of how fast we can go into it properly. The American Society of Civil Engineers has gone into it and has established definite quantitative yardsticks and the principal criticism I have heard is that it is quantitative and not qualitative.

As a matter of fact there was a motion adopted within the Board of Directors and those criteria were coupled with the fact that the Secretary of the Society was to take up this subject with the Secretaries of the other National Engineering Societies, the Secretary of the S. P. E. E., and I think one or two other institutions, a discussion of how far and how well those rules, those yardsticks which have been set up and which are operative, are satisfactory.

I placed that matter before your Secretary and I am very much in hopes, as time goes on, that he will find it practicable to meet with us on this problem. It is one which we think we are ready to take hold of.

There was one figure that flashed through my mind as you were talking here this afternoon. It may be of interest to you. If I am not mistaken the number of engineering students graduating each year in Civil Engineering is something in the neighborhood of 16,000. I do not know if I can make any particular application to this thought, but it did come to me and I thought I would give it to you.

At the present time there are applications coming into the A. S. C. E. each year for about 650 of those students. That is a fairly small percentage.

Prof. Hammond: The 16,000 is the total number of Civil Engineering students.

Mr. Seabury: Then my figures are all wrong.

Mr. Wickenden: There are between 1,500 and 2,000 graduates each year.

Mr. Seabury: I see I had the wrong data. I am personally very much interested, and our Student Chapter Committee is much interested, in what the specific things are that can be done with the students. We do not want to load anything on them that they should not have.

The comment has been made that too frequently speakers are furnished to engineering schools and they are not satisfactory when they get there. They find that the speaker diverts from his topic and generally gets down to preaching. After all is said and done, I am told that the speaker is not satisfactory.

We will not burden you with that. We have started, at the suggestion of our Student Chapter Committee, something which may be of help to you. We are collecting, and plan to have ready for you in the fall, a series of lantern slide lectures on specific topics, specific problems, generally speaking, which you will be able to get and which we will be glad to ship out to you free of cost. That will include not only the slides but the words to go with the slides as well. If you are interested in them we will send them to you, and in another year we will take the pains and the expense to increase the number so that we may have a library, shortly, of perhaps 20 to 50 such lantern slides which you can make use of.

They will take anywhere from 30 to 50 minutes, or an hour to run. The words will be prepared for you by the people who are interested in the topic themselves and they will furnish us with the pictures.

If we can learn—and I am sure I speak here for the other Societies—of practical ways in which, with a reasonable amount of expense, we can be of real assistance to you, we shall be very much pleased.

2. What Specific Contribution Can The National Societies Make to Engineering Education Through the Branches?

C. M. Jansky, A.I.E.E.

When the subject was first presented to me, I remarked; that is a poser. After several weeks of pondering and cogitation, I am still of the same opinion. Before making any suggestion relative to the specific contribution that the National Technical Societies can make through the branches, it may be well to consider briefly the situation from the standpoint of the branches.

The underlying purpose for organizing the Student Branches of the American Institute of Electrical Engineers was stated by President Scott in 1902 in the following words:

"The principal purpose for bringing the work of the Institute directly to the student is to enable him to keep in touch with actual things and to give him a definite idea of the kinds of work which lie before him, and for which he is preparing. Fortunate will it be if we can lead him to see that in the development of an electrical engineer there should be something besides technical training—that logical thinking and clear expression and general culture are indispensable in a profession that is closely related to so many departments of science and engineering as well as industrial and commercial and social activity, and that he must be a broad man with a broad educational foundation, who would aspire to the fullest usefulness and success."

Purpose and accomplishment in this, like in so many other human endeavors, have been quite dissociated and for no particular fault of the sponsors, organizers, or students themselves, but mainly because of conditions over which neither the parent body nor the members of the branches have absolute control. In order that a keener appreciation may be had of the problems of the Student Branches a brief review of some of these conditions will be apropos.

Some thirty or thirty-five years ago there were, in most if

not in all institutions of higher education, flourishing forensic and debating societies which provided training in public speaking and in leadership such as it was hoped the Student Branches would furnish the young engineers. These societies flourished because they were the centers of the literary and social life of the students. They provided avenues of self-expression, of which we hear so much today, in many different activities. Among the more significant may be mentioned dramatics, debates, declamations, reading of papers, and the social hour or two after the formal program.

To be an official of one of these societies was a distinction and honor much coveted. It was considered a mark of distinction to participate in the program, and even faculty members occasionally attended and participated in the proceedings.

Today most if not all of these literary societies are in a moribund state. No one seems to pay the slightest attention to their meetings; members are few and more or less inactive; it is no longer an honor to be an official of such an organization, and the apparent eccentricity of belonging to such a society is more a mark of distinction than any literary or forensic achievement.

Then, the student's extra curricular life was relatively simple while today the number of extra curricular activities, each under a separate organization, has so shifted the students' interests that even the academic training is suffering from inattention, and the question, Should a student study? is not as paradoxial as it sounds. What are some of the demands of an engineering student's time?

First, and most important, are his scholastic duties. The engineering students are required to complete in eight semesters in the University of Wisconsin 146 credit hours of work exclusive of Freshmen Lectures, Physical Education, or Military Science. This means an average of 18 to 19 credit hours per semester. Assuming that each credit hour requires two hours for preparation and one for recitation, the student is expected to devote from 54 to 57 hours per week to his

classroom work. This is one to one and one half hours more per day than is required of union labor.

This, however, is not all of the demand on his time. The distinction and honor associated with the holding of office in a technical or literary society has been absorbed by the honorary and professional fraternities, Tau Beta Pi and Eta Kappa Nu. These also hold meetings which the student is expected to attend.

Then if he has any athletic ability he is importuned to try for a place on some athletic team. If he fails to make the varsity squad, the fraternity team demands that he uphold its prestige in interfraternity contests. Nearly every Saturday afternoon he is expected to show his school spirit by attending inter-collegiate contests, for which he is supposed to have previously acquired enthusiasm at a "pep" meeting.

The social activities formerly associated with the literary society now center around the fraternities which in addition to their weekly meetings hold regular formals and informals. For fear that after all of these activities the student might have a few minutes left to devote to the work of the Branch, the Union Board fosters weekly dances on Friday evenings.

These are only a few of the activities that are demanding the spare time of the student. Decorations for home-coming; students' publications; preparations for St. Patrick's Day; the union vodvil; the band and several other activities could be mentioned.

With so many enterprises competing for the student's time is it any wonder that an activity whose aim is to train leaders in engineering is dormant and lifeless. No distinction and honor attaches to the office of president or secretary, but there is attached much hard work in securing members, preparing programs and in keeping up the spirit of an organization almost unrecognized by the student body, by most of the faculty, and by the future employers of engineering students.

Proficiency in athletics is rewarded by a letter, and if the proficiency is combined with good scholarship a medal is sometimes awarded.

It is not the material reward, however, that animates students to activity in fraternities, athletics and the like, but the acclaim of their fellow students. Enthusiasm is a contagious emotion, and it is only natural for the individual student to participate in those activities in which he can secure the most renown. Ambition for the plaudits of the populace was not limited to Caesar or Anthony, but it is an affection common to the race.

In short, the ineffectiveness of the Branches is a result of the shifting of honor and acclaim from scholastic and literary achievement to athletic prowess and the transfer of the students social activities from the literary societies to the fraternities, unions, and other like organizations.

In brief, therefore, the problem of the Branches is to devise ways and means to restore literary activities to their proper place of eminence and distinction. Material prizes may serve as a stimulus, but unless some acclaim, some distinction, some public recognition is made of the winning of the prize, very few competitors will appear. Is it possible to make a literary activity so interesting and stimulating that it can compete with the many agencies mentioned? Perhaps not, but much can be done to arouse more interest in the Branches than is at present manifest.

What can the national societies do to assist in the solution of this problem?

In the first place as the employers of the graduates of engineering schools are in most instances members of the national organizations they can very properly stimulate interest in the work of the student branches by recognizing as possible future leaders in engineering those students who are leaders in branch activities. It seems reasonable to insist that the management and promotion of the activities of the engineering societies require ability of as much potential value as the ability to kick a goal. The placing of more emphasis on the students' participation in the work of the local branch as a qualification for employment is one contribution that the national societies can make. What else?

In my judgment the supreme need of the student body of today is not more mechanics, more differential equations, more thermodynamics and electrodynamics, but more of enthusiasm, inspiration and vision. They are surfeited with a continuous diet of mere scholastic tabulum for four years. Listen to the following plaint of one disillusioned boy:

"Four years ago I entered the University with the intention of making engineering my life work. Today I stand on the threshold of that work, bewildered and uncertain. I don't know whether I have chosen the wrong profession; I don't think I have, but the significant thing is that while at Wisconsin nothing has happened to stimulate or encourage my interest in engineering work; there has been nothing that inspired me; nothing but formulas, the substitution in an endless number of formulas."

Lest you say that this is an isolated case, I want to say that I have read that boy's despondent cry to several seniors and they all confessed that such sentiments are more prevalent than we, the faculty, imagine. To me it seems a great tragedy that a boy, who instead of "rejoicing as a young man to run a race" feels already defeated before life's race is begun.

If the youth of our colleges is to undertake life's problems with faith, courage and zeal, it must be conscious of the worth of the many human activities, and of the preparation necessary to engage successfully in them. Faith, courage and zeal are as much, if not more, the product of inspiration than of knowledge, for despite the bravado and assumed sophistication of our students they, like King Lear's fool, must cling to the hand of some Kent to give them courage to face the unknown.

While the giving of guidance and inspiration to the students is the prime function, and major part of the work of the members of the faculty, the National Societies can be of material assistance.

How? By carrying out the ideals of the profession as expressed in the Christmas Greetings to the members of the

American Institute of Electrical Engineers, which reads as follows: "The Institute enters its forty-fifth year, conscious of an outstanding position as an organization for service, for holding high the ideals of the profession, for furthering the advance of engineers and engineering, and, *mark this*, for giving *guidance* and *inspiration* to the embryo engineers in our schools and colleges."

These are not mere idle words of a man with a fluent pen, for President Schuchardt has been most active during the past years in giving vitality to the sentiments quoted. He has done this by participating actively in some of the Branch and Section meetings and by monthly messages in the JOURNAL of the Institute. The message in the May issue is directed to the "Members of our Student Branches" and reads in part as follows:

"Your education has aimed to prepare you to add to the richness of life—your life and your fellows. If you have become technicians only you are in danger of continuing along narrow lines with a limited outlook. If, on the other hand, you have broadened your viewpoint and your contacts with the humanities without sacrificing the acquirement of the necessary technical foundation, if you have familiarized yourselves with the ideals that have inspired mankind through the ages, if you have developed an appreciation of the beautiful and take an interest in history and art as well as in engineering and economics, then you are indeed well started on the road leading to a balanced and well rounded life. We do not live by bread alone, and a life wrapt up in materialism misses the rich enjoyment that comes from the finer, the cultural and the spiritual contacts."

This message has significance, not so much by what it says, as by its source. It comes from one who employs college graduates and the sentiments expressed show that his interest in the young men is not simulated, nor is it aroused by the mere desire for more efficient production units. It is not an interest in young men as robots, but as sentient human beings. Such interest gives faith, courage and zeal.

W. K. Hatt, A.S.C.E.

I feel somewhat apologetic when I consider that I have to follow the splendid paper that was presented by the last speaker. I think he has drawn a very complete and fair picture of student life and activities on the campus.

It is my observation that a large part of the activities is carried on by a very few men. One man has many honors. The Student Branch certainly can be served by the men who are not so prominent. That is usually the case with us.

There is no necessity for narrowing the student by a method of teaching technical subjects. I have a theory that most technical subjects, so-called, can be taught in a broadening way. For example, any man who teaches what we call masonry construction certainly has the roots of it in past history, in art and philosophy and all those things which make an intelligent man, so that the professor does not have to limit himself to some formula for the strength of a beam or the bearing power of soils. Because of his knowledge of some of these things he can go back and inspire and broaden the field for the students. I think that can be done in many other subjects.

One problem in the universities is the pressure put upon us by the National Societies of the various types to establish Student Branches. I have had the occasion to oppose, through some misunderstanding, the establishment of student branches of the American Society of Testing Materials in Purdue University and also Student Branches of the American Concrete Institute. I do not think they belong there at all. Yet the men who are anxious to build up the organizations think it is a good thing for the University. It is not.

Of course the boys who belong to the Branches are busy. They want to hold a meeting and they come around to the professor and ask who the speaker is going to be. They want to know if Professor So-and-So cannot come around and give them a talk. Then they will say that they hear enough about and from some professor and they do not care to hear any more.

We learned, two or three years ago, to let that burden fall on the students themselves. We let them make out a list of the meetings each month and secure a speaker. If you put the burden on the shoulders of the students they will carry it themselves. Otherwise, they will put it on the faculty.

Our Student Branch is helpful to the college. At the beginning of the fall term they bring all the Civil Engineering students together to what they call a smoker. They sell memberships there and they start the thing going. The freshman, as a rule, does not like to give up the 50 cents, but we get them together, give them a cheap cigar and a hot dog and he will pay.

The American Society of Civil Engineers makes it easy for the seniors to join the parent society. They also supply the seniors with a list of jobs open to them. I recollect, with a good deal of pleasure, the fact that the Illinois Section of the American Society of Civil Engineers, this last year, gave several scholarships among the students of Purdue University and Illinois University. I think they did the same thing in the University of Wisconsin. They gave them to men selected for high scholarship and leadership. They have their entrance fees and their dues paid for the first year of the membership in the American Society of Civil Engineers.

In Indiana we have no Section of the American Society of Civil Engineers because most of our prominent engineers live in Chicago, or some of the big cities and they prey upon our small people in Indiana.

The American Society of Civil Engineers sends speakers to our annual dinner, which is held by the Branch each year. I think the Society does a great deal for us.

There is one thing that I think the Society might do that has been on my heart for a great many years. A good many years ago I started to secure large portraits of fathers of Civil Engineering. I secured a portrait of Wellington. He was one of the pioneers of railroad science. The portrait had been in the possession of his sister. That is enlarged now

and is on the walls of the building. We have one of J. B. Francis and one or two others.

I think the American Society of Civil Engineers would do a good thing if they would arrange with some firm to supply to the colleges a selected list of portraits of the fathers of the profession, French, English, American. Those are great inspirations to the students.

What the Branch also does is to have, each year, some one of the students write up the life of one particular man and read it to the Society. Those lives are inspirations and when the boy comes in contact each day with the portrait of the man it gives him something that he has not had before, something outside the formulas of applied mechanics.

R. A. Seaton, A.S.M.E.

The object and purpose of Student Branches as given in the record, and index, for 1927 of the A. S. M. E. is to "enable the engineering student to obtain a conception of organization and operation of Engineering Societies."

I think that is altogether a too narrow statement of the purpose. A very much better statement, I think, is contained in the manual for the operation of the Student Branch which was issued by the Committee on Relations with Colleges of the A. S. M. E. Probably those of you who are honorary chairmen for the American Society of Mechanical Engineering Branches are familiar with this.

The objects, as stated in this pamphlet, are to give the student some acquaintance with the practical side of the field of Mechanical Engineering. The second object is to furnish the student with the principal publications of the Society and keep him in touch with engineering progress. The third object is to develop the student's initiative and ability to speak in public and to familiarize him with the parliamentary procedure of organizations and learned societies.

The fourth object is to establish fraternal contact with the fellow students in engineering and have them meet older

men engaged in engineering. The fifth object is to permit the student to attend, as a welcome guest, the general meetings of the Society.

I think there might well have been added another purpose, to help develop in the student a professional and industrial consciousness, despite the academic atmosphere in which he is placed, help make engineering real to him instead of something about which he reads in textbooks. I think that is particularly true with us who are situated remotely from industrial and manufacturing regions.

There are a great many specific contributions now being made by the American Society of Mechanical Engineers to engineering education through assistance rendered to the Student Branches. Among those are the following: (1) One of the principal ones is the recognition of the Student Branches by the Parent Societies and the designation of the members of the Student Branches as Student Associates.

(2) Encouraging joint meetings with other Student Branches and with local Sections. Our boys get a good deal of a kick out of meeting with the Kansas City Section of the American Society of Mechanical Engineers, for example.

(3 Providing a discount on Society publications. *The Journal of Mechanical Engineering,* for example, is furnished to student members at half the regular price that it is furnished to non-members of the Society.

The Society awards two cash prizes of $25 each annually, and certificates of award for the best paper, or thesis presented by members of the Student Branches.

There is another prize of $150 awarded annually for the best paper on a designated subject dealing with some specified division of the general topic, Influence of the Profession Upon Public Life.

The Society provides for an official pin, student pin, and a membership card. It encourages attendance at the general regional and local section meetings. It publishes, both in the monthly bulletin to the Student Branches and in the American Society of Mechanical Engineers News, reports of the meetings and activities of the Student Branches.

It provides for the Student Branches to secure printing done at cost. It provides for the excuse, from the first, of dues of members of Student Branches if they join the Society within one year after graduation. It provides for the enrollment, after graduation, as members of the local Sections, of those members of the Student Branches who wish to enroll, without any additional payment.

It helps in the securing of employment through the employment service bulletin which is furnished to members of the Student Branches, or which is furnished to the Student Branches without cost.

It provides prominent engineer speakers for the Student Branches. It provides for the manual for the operation of a Student Branch, and I think it has been a real contribution to the work of the Student Branches. There is a Conference of Student Branch delegates provided for at the annual meeting and at the spring or regional meetings.

This is a rather formidable list of activities which the Society is already carrying on and which I think is of a great deal of value to the Student Branches.

The question of what additional contributions should be made is a rather difficult one to answer. I think that probably the improvement of the services now being offered and the extension of those services, perhaps, would be helpful.

Only those men who are good speakers should be asked to represent the Society at the Student Branches, men who will make talks which will get across to the students. Sometimes there is a tendency for the speakers, I think, to devote a little too much of their time to trying to inform the students of the merits of the National Societies, and too little attention is paid to inspirational matters and perhaps technical matters.

Perhaps there might be some method of following up the students after graduation in order to try, if possible, to see that they continue as members of the Society, or really take out official membership in the Society. I think some follow-up scheme of that sort could be worked out which would be very helpful.

Of course, the matter of securing employment is of great interest to the members of the Student Branches. I believe that the employment service could be expanded somewhat. The Societies, through their membership, I think, could very well undertake to arrange greater opportunities for summer employment between the junior and senior, and perhaps between the sophomore and junior years.

In one of the papers presented this afternoon it was pointed out that 50 per cent of those men who had achieved outstanding success in the study that was made had had industrial or engineering experience before graduation. I believe if the industries, through the National Societies, will organize some kind of employment service, summer service, for the undergraduates, it will be an active and very well worth while undertaking.

Perhaps some additional prizes might be offered in the architectural profession. There are competitions which are very widely participated in by the architectural students in colleges, possibly something of that kind could be developed for the various groups of engineering students.

I think it would be very well worth while for the Societies to offer the prize of membership, the waiving of the initiation dues for a certain number of men from the Student Branches perhaps who have been very active in Student Branch work and who have carried their academic work with a high record and have certain other standards which might be set up.

In general, however, I think the National Engineering Societies are already rendering numerous and specific contributions to engineering education and the principal progress that can be made will be through the development and the better carrying out of those organizations, those means of assistance which have already been set up.

Edward Bartow, A.I.Ch.E.

In July of 1927 Professor H. L. Boling, of the State University of Iowa, suggested to the Secretary of the American

Institute of Chemical Engineers that something should be done to stimulate the interest of the Student Branches of the Institute and to give them some adequate return for their dues.

As a result of that letter the Council of the Institute decided to make it the business of a special committee on Student Branches to see that each branch was visited twice a year by members residing in the immediate vicinity. That was made the business of a special committee as it was felt that the detailed work would be too great a load to place on the officers of the Institute, who are already giving as much time as they can afford to its affairs. A committee was appointed.

At the beginning of the year there were thirteen Student Branches and one was added during the year. During the year the chairman of the committee has written to the sponsor of each Branch asking for suggestions on industrialists in the vicinity whom they would like to have visit the Student Branch. The response was quite good. Two of the sponsors did not reply at first but later they did give replies. Letters were then sent to one or two members, chosen from among those mentioned by the sponsors, and the response there was again good. Practically every Branch was chosen by some one of these men as a Branch that he would like to visit and one which he could serve.

Requests were made that after these visits the chairman be supplied with the titles of the addresses given, the number of students in the Branch, and any other items that would be of interest to the Society.

Of the 14 Societies I have 10 reports, and 8 were visited by Institute members, two others could not be visited this year, but it is expected that visits will be made early next year.

John Younger, A.S.I.E., S.A.E.

The Society of Automotive Engineers is the technical association of the world's greatest industry. It is distinct in its field from the A. S. M. E. and should be kept distinct to

preserve the esprit de corps which is so strongly manifested in the Society's membership. Through its divisions it covers the technical problems relating to aviation, automobiles, trucks, coaches, and tractors. It deals with problems that arise out of design, production, operation and maintenance of its products, a thoroughly engineering program.

Here, therefore, is a splendid field for the young engineer to enter upon, and the Society should realize fully the obligations to its young men.

However, it is only recently that the S. A. E. has considered the question of student sections and in the fall of 1927 the first Student Branch of the Society was started at the Ohio State University. Since then four other Branches have been started, and others are being considered.

The automotive industry did not at first take very kindly to the college graduate. One of its leading firms, the Ford Motor Company, in fact expressed its disbelief in their value in no uncertain terms, but this attitude is now changing. The industry is getting over its youthfulness. Men in it are coming rapidly to the time when they see their places will have to be taken by more youthful men and they are turning to the college man.

Naturally they expect their technical society to contribute to the work of aiding these men find their footing rapidly, and this it is doing.

Students are allowed to join the Society for the sum of $3.00 per year. For this they are entitled to the *Monthly Journal* which is produced at an expense of 40 to 50 cents per copy. They are also entitled to attend any of the meetings of the Society or its sections. They are eligible to compete for a special student prize or award for the best paper submitted. Sometimes special meetings for students are held, but they are usually in the Detroit territory. Students are also encouraged to take part in the discussions. They also receive the *Employment Bulletin*.

Further, the Society is becoming interested in the education of young men, and some of its members have contributed

papers dealing with the training and education of men for the industry. The Society aids in securing outside men for student section meetings.

A special committee headed by Major Hecox, Assistant Chief Engineer of the Cadillac Motor Co., is also in force to superintend and encourage the work of the student sections.

Altogether the Society is initiating a valuable piece of work in getting these activities under way.

The Conference passed the following motion: "That this Conference on Student Sections for the S. P. E. E. request the Secretaries of the National Engineering Societies to take steps to learn where suitable photographs and engravings of the prominent deceased members of various branches of the profession can be obtained and to notify the various Branches and Chapters."

"In order that the S. P. E. E. may make a specific contribution, through the Student Branches, I move that this meeting recommend to the Council of the Society that the Society place the address delivered today by President Kimball in the hands of each member of each branch of our engineering societies as its topic."

E. A. Holbrook, A.I.M. & M.E.

Insofar as is possible, I wish to present the viewpoint of the American Institute of Mining and Metallurgical Engineers on the questions of related undergraduate student sections and to outline the student section plan in use at the University of Pittsburgh.

Briefly, the Institute encourages the class of membership known as student associates. A student in good standing in an approved school who has been nominated by a least three instructors (one of whom must be an institute member) may affiliate with the Institute as a student associate by payment of $2.00 annual fee, for which he shall receive "Mining and Metallurgy" or technical publications and be privileged to attend meetings of the Institute and to use the Engineering Society's Library and the Employment Service. Student

Associates who apply for Junior membership within six months after leaving school shall have their first year's dues remitted.

Membership in the Institute is made up of men engaged in the Mineral Industries, and for this reason covers a wide variety of interests, including Coal and Metal Mining, Mineral Technology, Geology, Oil and Gas Production and Utilization, Ferrous and Non-ferrous Metallurgy, Mineral Preparation, and reaches far into the utilization of the various products of the mines. As a result one difficulty in a student branch at any school is to discuss subjects which will interest the whole membership. For example a student studying Metallurgy may be little interested in the geology of an oil field, and yet both Metallurgy and Geology are properly within the scope of the Institute's interest.

In the School of Mines at the University of Pittsburgh it has been found advisable to separate A. I. M. & M. E. student section into even smaller sections, based on the department in which the student is majoring. For example the students of the Oil and Gas department have their own student section in which Oil and Gas problems are discussed. In the same way, the Mining Department, the Metallurgy Department, and the Petroleum Refining Department each has its own individual student section holding weekly meetings which consider topics of closest professional interest.

However, once in two months a joint meeting is held, and is in charge of the students of one of the departments. In this way the general Institute interest is maintained and the students get some insight into related professional fields.

The plan is frankly an attempt to foster the interest of the School of Mines students in the American Institute of Mining and Metallurgical Engineers and to overcome the difficulty experienced at many similar schools—that is, to hold the interest of the student.

SELECTED PAPERS OF THE 1929 SESSION OF THE SUMMER SCHOOL FOR ENGINEERING TEACHERS

MACHINE DESIGN DIVISION

The following papers were presented before the Mechanical Engineering Session of the Summer School for Engineering Teachers, held at Purdue University in 1929. The present installment is one of a series that presents some of the results of the Session. Papers relating to the history of mechanical engineering, reports of committees of members of the session and selected papers of the Heat Power Division of the program have appeared in preceding numbers of the *Journal of Engineering Education*. Following numbers of the *Journal* will contain selected papers of the Production Division of the program and papers relating to educational principles and practices. These papers are being reprinted in bulletin form and may be secured by application to the office of the Director of the Summer School for Engineering Teachers, 99 Livingston Street, Brooklyn, N. Y.

The papers here published are those which relate most directly to methods of teaching machine design. Through the cooperation of the American Society of Mechanical Engineers, papers of more definitely technical content have been published in *Mechanical Engineering* and in the *Transactions* of that society. These papers have also been bound together as reprints and may be secured as stated above.

PURPOSES AND SCOPE OF COURSES IN MECHANICS OF MACHINERY AND MACHINE DESIGN[1]

By O. A. LEUTWILER

Professor of Mechanical Engineering Design, University of Illinois

I. Mechanics of Machinery

The term "Mechanics of Machinery" as here used will be interpreted as including a study of the following general subjects: (*a*) Mechanisms, (*b*) Kinematics of Machinery, (*c*) Dynamics of Machinery.

Mechanisms. The term "mechanisms" in its broadest sense may be defined as that branch of the science of mechanics which deals with the design and construction of a machine. In a somewhat more restricted sense, the term "mechanism" is also applied to a combination of two or more bodies having definite shape and so arranged that the motion of one of these bodies produces the motion of the others. When several such mechanisms are grouped together to transmit forces and motions, the combination is called a machine. Hence in this division of the subject the student becomes acquainted with the elements that make up mechanisms as well as the operation of such mechanisms. In order properly to cover the subject of mechanisms it is suggested that the contents of the course should include a discussion of the following topics:

(1) Pairing Elements and Links;
(2) Kinematic Chains and Mechanisms;
(3) Linkages and Their Variations;
(4) Analytic and Graphic Analysis of Motions in Common Forms of Linkages;
(5) Cams, Toothed and Screw Gearing;
(6) Analysis of Gear Trains;

[1] Condensed version of a lecture presented at the Summer School for Engineering Teachers, Purdue University, June 28, 1929.

(7) Flexible Connecters;
(8) Intermittent Gearing, Ratchets, Reversing Mechanism, Indexing Devices, Clutches and Clutch Operating Mechanism

Kinematics of Machinery. In kinematics of machinery the study of motion is dealt with; that is, the relations existing between displacement, time, velocity and acceleration of the machine parts. A discussion of the following topics should be covered in this division of the subject:

(1) Actual and Relative Velocities of Machine Parts;
(2) Velocity Polygon;
(3) Instantaneous Center of Absolute and Relative Motion;
(4) Acceleration of Machine Parts;
(5) Coriolis Law;
(6) Acceleration Polygon.

Dynamics of Machinery. In the division of dynamics of machinery the action of forces on bodies is discussed, but it should not include the analysis of the elastic forces and the deformations in machine parts. An adequate treatment would include a discussion of the following topics:

(1) Inertia Forces;
(2) Combination of Static and Inertia Forces;
(3) Balancing of Machine Parts;
(4) Force and Mass Reduction;
(5) Applications.

Purpose of the Course. From the foregoing it is evident that the purpose of a course in Mechanics of Machinery is to acquaint the student with the elements that make up mechanisms and the motions and forces produced in the operation of such mechanisms; also to develop the habit of obtaining solutions to problems in a logical manner.

II. Machine Design

Purpose of the Course in Machine Design. The purpose of the course in Machine Design is to teach the student the application of the fundamental principles of mathematics,

pure and applied mechanics, resistance and properties of materials and shop processes for the creation of elements of machines or complete machines which will prove useful to man. It also should encourage the student to develop logical methods of reasoning in applying the principles enumerated above and, in addition, should teach the student when and where to place reliance upon analytical methods and when to exercise practical judgment.

Scope of the Course. The work covered in a course in Machine Design may be grouped under the following three heads: (*a*) Theory, (*b*) Computations, (*c*) Layout of the Machine.

Theory. In this division of the work, the theory underlying the design of machine parts is taken up in the form of lectures, recitations, quizzes and problems. The following list of topics is suggested as suitable material for a general course in Machine Design:

(1) Stresses and Strains in Machine Parts;
(2) Materials Used in the Construction of Machine Parts;
(3) Fastenings—Rivets and Riveted Joints, Bolts, Nuts, Screws, Keys, Cotters and Pins;
(4) Cylinders, Plates and Springs;
(5) Flexible Connecters—Belts, Ropes and Chains;
(6) Gearing—Friction, Spur, Bevel and Screw;
(7) Couplings, Clutches and Brakes;
(8) Shafting, Journal, Bearings and Lubrication;
(9) Flywheels;
(10) Machine Frames;
(11) Use of Modern Welding Methods.

Computations. The term "computations" as here used refers to the calculations and sketches required in arriving at the dimensions of the various parts of the machine to be designed. This part of the course is started after a certain amount of ground has been covered in the theory part of the work. The machines selected as suitable for design should be comparatively simple, containing elements in the design of which simple and combined stresses are involved.

The following machines have been found satisfactory; punching and shearing machines; drum hoists; speed reducers; cranes; hydraulic and pneumatic riveters; etc.

Machine Lay-out. Having completed the calculations, the student should make a drawing showing the assembly of the machine.

CLASSROOM METHODS IN MACHINE DESIGN[1]

By O. A. LEUTWILER

Professor of Mechanical Engineering Design, University of Illinois

The work covered in a general course in Machine Design may be grouped under the following three heads: I—Theory, II—Computations, III—Machine Lay-out.

I. Theory

In this division of the work, the theory underlying the design of machine parts is taken up in the form of lectures, recitations, quizzes and problems.

Lectures.

(1) Students should prepare for the lecture by studying the assignment.

(2) Instructor explains the most difficult parts of the assignment.

(3) Instructor supplements the treatment in the textbook with material drawn from his experience, and brings to the attention of the students recent improvements and modern practice.

(4) Instructor should lay emphasis on the following points:
   (*a*) The need of logical and analytical thinking.
   (*b*) The need of developing initiative and originality.
   (*c*) When and where to place reliance on analytical methods and when to exercise judgment and common sense.
   (*d*) The ability to get things done.

(5) Instructor should give the students some idea of how and where additional knowledge may be found, calling their attention to modern literature.

[1] Condensed version of a lecture presented at the Summer School for Engineering Teachers, Purdue University, July 1, 1929.

Recitations

(1) The class should be divided into sections containing not more than fifteen students.
(2) Students should come to class prepared on a definite assignment and should be held responsible for the theory as well as for the application of the theory to specific problems.
(3) Students should be sent to the blackboard and each student assigned definite work by means of the card system.
(4) Instructor should circulate around the room, calling the students' attention to errors and by means of questioning assisting the student in finding his way out of difficulties.
(5) The more difficult problems or theorems may be discussed.

Quizzes and Problems.

(1) Short written quizzes on theory or problems.
(2) Full period quizzes on theory and problems.
(3) In the solution of problems permit the use of books, problems, etc.
(4) Two kinds of problems as follows:
    (*a*) To determine dimensions of parts, having given operating data.
    (*b*) Given dimensions to determine unit stresses, pressures, etc.

II. Computations

The term "computations" as here used refers to the calculations and sketches required in arriving at the dimensions of the various parts of the machine to be designed. This part of the work is started after a certain amount of ground has been covered in the theory part of the course.

The students may work independently on individual problems or they may work in groups of two or more, each group being required to design a series of machines.

Statement of the Problem.

(1) Provide each student with a complete and clear statement of the problem, preferably in the form of a specification.

(2) Discuss the specifications with the students and encourage them to find out what their design would have to compete with on the open market. Use trade catalogues for this part of the work.

Method of Procedure.

(1) Each student should submit a series of sketches by means of which he gives the instructor a general idea of the design he expects to submit.

(2) Each student should submit a "method of procedure" which he proposes to follow in arriving at the proportions of the various elements of his design.

(3) The "method of procedure" should be discussed with the individual student as he prepares it. The entire class should later take part in the discussion of the "method of procedure."

(4) Thus, finally, a standard "method of procedure" should be formulated.

Calculations and Sketches.

(1) Each student should make a complete set of calculations, accompanied by sketches, arranged in a neat and logical manner.

(3) From time to time these calculations should be submitted to the instructor for checking and approval.

III. Machine Layout

Each student, after completing the calculations and sketches, should make a drawing showing the assembly of the machine and, if time permits, possibly a detail of an important part of the machine, such as the frame.

APPLICATIONS OF MECHANICS TO MACHINE DESIGN [1]

By O. A. LEUTWILER

Professor of Mechanical Engineering Design, University of Illinois

In designing a machine, the three important steps taken are as follows: (1) Determine what motions are necessary to accomplish the desired result at the output end of the machine. This requires laying out the general form of the various elements used in the machine as well as the motions of these elements. (2) Make a study of the type and magnitude of the forces acting upon each element of the machine. (3) Determine the nature and magnitude of the stresses set up in each element and proportion the elements so that they will readily transmit the forces coming upon them.

The various steps just enumerated require first, inventive ability and a knowledge of the form and action of machine elements and their combinations when used for transmitting the desired forces and motions; second, a knowledge of mechanics in order to analyze the various forces and motions produced; third, a knowledge of the properties and strength of materials; fourth, in order to build the machine at a reasonable cost the designer should know modern shop processes and in addition must possess a sense of proportion so as to produce a neat appearing machine. The matter of appearance is an important factor and should receive serious consideration.

I. Application of Analytical Mechanics

In order to give some idea of the extent of the knowledge of analytical mechanics that should be at the command of a designer of machinery, attention is directed to the analysis of the forces acting in a six-cylinder gas engine. It will be as-

[1] Condensed version of a lecture presented at the Summer School for Engineering Teachers, Purdue University, July 5, 1929.

sumed that the following data pertaining to the engine are known:

Assigned Data.

DIMENSIONS

R.p.m.	3600
Number of cylinders	6
Diameter of cylinders	3¼″
Stroke	5″
Length of connecting rod, center to center	10½″
Distance of center of gravity of connecting rod from crank pin end	2½″
Diameter of wrist pin	⅞″
Diameter of crank pin	2″
Diameter of main bearing	2¼″
Center of gravity of unbalanced weight of crank from center line of crank shaft	2.44″
Time for 50 complete swings of connecting rod about center of wrist pin end	50 sec.

WEIGHTS

Connecting rod, complete (including bushings)	2.50 lbs.
Piston, complete (including wrist pin, rings, etc.)	1.62 lbs.
Estimated unbalanced weight of crank	4.80 lbs.

TIMING

Inlet valve opens 6 degrees after head end dead center.
Inlet valve closes 46 degrees after crank end dead center.
Exhaust valve opens 42 degrees before crank end dead center.
Exhaust valve closes 8 degrees after head end dead center.

GAS PRESSURES, ETC.

Compression volume, 25 percent of piston displacement.
Maximum explosion pressure, 300 lb. per sq. in., absolute.
Pressure rise completed at 2.5 percent of stroke.
Development of expansion curve begins at 4.7 percent of stroke.
Mean suction pressure, 13.5 lb. per sq. in., absolute.
Mean exhaust pressure, 16 lb. per sq. in., absolute.
Atmospheric pressure, 14.7 per sq. in., absolute.
Pressure at beginning of compression, 13.5 lb. per sq. in., absolute.
Exponent for expansion curve, 1.3.
Exponent for compression curve, 1.3.

Indicator Diagram. From the assigned data pertaining to the behavior of the gas in the cylinder and the timing data a probable indicator diagram is constructed on a stroke line base. The expansion and compression lines follow the law $pv^n = C$. To facilitate the solution of this equation in order to obtain a series of points for plotting the curves, the use of logarithmic cross section paper is suggested. For any crank position the effective pressure on the piston is obtained by subtracting the back pressure, equal to the atmospheric pressure, from the forward or gas pressure and multiplying the result by the area of the piston.

Piston Inertia. The next step is to calculate or determine graphically the acceleration of the piston and then compute the inertia force of the piston, since its mass is known.

Rod Inertia. To determine the effect of the connecting rod, a kinetically equivalent system made up of two masses A and B joined by a weightless rod may be substituted. These masses are located at distances a and b from the center of mass of the rod. Knowing the radius of gyration k about an axis through the center of mass of the rod and locating mass A at the wrist pin, the location of the mass B can be calculated from the relation $ab = k^2$. By means of graphics, the accelerations of the masses A and B can be determined and from these the inertia forces may be calculated.

Crank Inertia. The inertia force of the crank has no effect on the piston or the connecting rod, but will create a pressure on the crank shaft bearings unless it is counterbalanced.

Resultant Wrist Pin Pressure. It is evident from the foregoing that the resultant force at the wrist pin may now be determined as well as the side thrust exerted upon the cylinder walls and the force transmitted through the connecting rod.

Turning Effort. The force transmitted by the rod to the crank pine may be resolved into two components, a radial and a tangential, the latter being called the turning effort.

The foregoing analysis applies only to one cylinder; hence, to obtain the resultant turning effort exerted upon the crank-

shaft, the combined effect of all six cylinders is plotted on a base line representing the developed crank circle. The area under the curve denotes work performed. The turning effort diagram is useful for determining the weight of the flywheel, the function of which is to maintain a uniform turning effort. The magnitude of this uniform turning effort is represented by the mean ordinate obtained from the area under the curve and length of the base line. During certain periods of the cycle the flywheel stores up energy, shown by areas above the mean ordinate and during other parts of the cycle, when there is a deficiency of energy, it gives up that which had been stored.

Shaking Forces. The forces that cause vibration in the engine are the following:

(1) The inertia force of the piston;
(2) The inertia force of the rod;
(3) The inertia force of the crank and crank pin.

The resultant of these three forces, obtained by means of a force polygon, represents the total shaking force. The shaking force diagram for a single cylinder is usually laid out on the crank circle as a base line, the center of the circle being used as a pole. Having laid out a complete polar shaking force diagram, the mean shaking force circle is then determined. It is customary to balance the major part of this total shaking force by fastening to each crank arm weights located diametrically opposite to the crank pin. The magnitude of this counterbalance weight is such that its effect is equivalent to the mean shaking force as represented by the radius of the mean shaking force circle. In the six-cylinder engine the combined shaking forces form a balanced system.

Acknowledgment. The analysis, as outlined in the preceding remarks, is that used in the solution of a problem assigned in the course of Mechanics of Machinery as given at the University of Illinois. For a detailed solution of a similar problem see the textbook entitled "Mechanics of Machinery" by Ham and Crane.

Coriolis Law. In the design of governors, centrifugal

pumps and fans or blowers, Coriolis Law will be found rather useful. This law applies to the acceleration of a body moving on a path, which itself rotates about a fixed point. It may be stated in the following words: The acceleration of the body is equivalent to the vector sum of three separate accelerations as follows:

(1) The acceleration of the body assuming the path fixed;
(2) The acceleration of the body, assuming the path rotating and that the body is a part of it;
(3) A supplementary acceleration at right angles to the path equal to $2\,uw$ in which u is the velocity of the body along the path and w the angular velocity of the path about the fixed center.

To obtain the forces acting upon the body, due to the accelerations just enumerated, multiply the accelerations by the mass of the body.

Theory of Vibrations. The use of increased speed as well as size of machine parts calls for designers trained in dynamics. The question of vibrations now becomes an important one and in the course of mechanics some attention should be given to the theory of vibrations.

II. Application of Strength of Materials

The old method of designing machine parts by the cut-and-try method is usually slow, uncertain and expensive, and as a result there is at present a definite trend in the direction of the application of mathematical analysis. This is especially true in the design of steam turbines, internal combustion motors, electric generators and high pressure vessels. In many such cases the customary application of the principles of mechanics of materials is not sufficient and as a result the theory of elasticity must be used.

The formulas commonly used in the design of machine parts are based on the following assumptions: (1) That the material is homogeneous; (2) The material used may be indefinitely subdivided without altering its properties; (3) That within the so-called elastic limit stress is proportional to strain.

In view of the fact that the first two assumptions are not true and the third only approximately true, designers must be careful in the use of formulas based upon them.

Many failures of machine parts can be traced to localized stresses that cannot be adequately dealt with by theoretical analysis; hence experimental methods of studying stress distribution are being developed. The photo-elastic method of determining stress is a good example of this development.

Localized Stresses. The importance of having generous fillets, thus avoiding sharp re-entrant corners, is frequently overlooked, and as a result the material is over-stressed and failure results. An axial pull on an ordinary bolt will cause a high concentration of stresses at the root of the thread, approximately equal to three times the average stress in the case of sharp V threads. A high localized stress will also occur at the point where the body of the bolt connects with the head unless a suitable fillet is provided.

A small hole drilled through a thin bar subjected to an axial pull produces a high localized stress. Experiments made by Preuss show that in the case of a thin bar having a semi-circular notch the intensity of stress at the bottom of the notch is approximately twice the average stress intensity.

When members similar to those just discussed are subjected to a large number of load repetitions, the localized stresses assume great importance.

Beams. For all ordinary problems pertaining to beams, the common flexure formula is suitable. It must be remembered, however, that there is a complicated stress distribution in the vicinity of the point of application of the load and that in certain cases a more extended analysis of stress is required. The actual variation of the shearing stresses in a beam is generally taken into consideration when the cross-section of the beam varies or has special forms.

Shafting. The majority of shafts used in machinery are subjected to a combination of torsion and bending. In a recent report approved by the American Engineering Standards Committee, it is recommended that the maximum-shear theory be used in designing shafts made of ductile ferrous materials.

High concentration of stresses occur at the bottom of keyways. Experiments on shafting equipped with keyways of standard size show that there is a decrease in the strength and stiffness of the shaft.

Cylinders. For years, dished heads for pressure vessels were designed by the use of empirical formulas. The latter gave satisfactory results as long as thin plates and low pressures were used. In those days, the dished head was made a portion of a sphere having a radius equal to the diameter of the shell and a knuckle of relatively small radius was used to attach it to the cylindrical shell. Theory backed by experiments, shows definitely that the head should be given an elliptical section. Modern methods of welding are also changing the methods of designing pressure vessels. High pressures accompanied by high temperature call for information pertaining to the strength and behavior of materials subjected to high temperatures.

Curved Beams. Curved beams are used to a considerable extent in machines, as, for example, chain links, crane hooks, and frames for punching, shearing, riveting and drilling machines. The straight-beam formula is widely used in the design of curved beams, for the reason that it is simple and easy to apply. In the case of cast iron frames initial stresses are usually present, and since the material is not homogeneous, designers may be justified in using the simpler straight-beam formula. The stress intensities obtained by the use of the latter formula are generally too small when applied to curved beams. Due to the fact that the curved-beam formula is complicated and difficult to apply, some investigators have suggested using the straight-beam formula with a correction factor. Experimental investigations, however, are necessary to establish values of this correction factor for different shaped cross-sections and degrees of curvature used in curved beams.

Friction Clutches and Brakes. The laws of friction as applied to clutch and brake design require considerably more study and experimental investigation than have been devoted to them.

Welded Joints. Within the last few years considerable

progress has been made by engineers in the use of the fusion-welding process as a means of building machine parts and of fabricating steel structures. Due to the elimination of patterns and the necessary foundry work and the reduction of assembly work, machine parts of all shapes and sizes are being made of steel by the use of welding at a cost below that of castings. In many cases machine parts made by the welded-construction method weigh much less than the cast parts that they displace. Furthermore, changes in construction found necessary or desirable during the assembling stage may readily be made by cutting openings or welding on new pieces. Designers, to make effective use of welded construction, must learn to resolve each complete machine part into its component element and to use the available standard steel shapes to the best advantage.

Repeated Loads. Considerable information as to the magnitude of the endurance limits is now available, but a large amount of experimental work is still necessary before definite conclusions can be established.

Rotating Members. The analysis of the stresses in high speed shafts, discs, drums, rotors and flywheels is probably beyond the reach of the ordinary undergraduates courses in machine design. Due to the use of high rotative speeds in modern machinery a number of manufacturers are now offering courses in advanced mechanics to selected groups of trained men. In other words, the manufacturers are assuming the duties of a university.

TEACHING OF MATERIALS IN MACHINE DESIGN *

By H. F. MOORE

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I. The General Problem of Teaching Materials

"Information" Teaching of Materials. Whether carried out by lecture, by recitation, by special laboratory courses, or in connection with shop courses most of the study of the materials of engineering done by technical school students is the gathering of information about the properties, manufacture and uses of materials. Methods of mathematical analysis of stresses and strains in materials are taught in one of the courses in applied mechanics, and the resulting formulas are afterwards used in machine design; but all this mathematical treatment is based on the assumption that material is homogeneous and can be indefinitely divided without change of elastic properties or strength, an assumption which is evidently far from exact for any of the common materials used in making machine parts. If the student is fortunate enough to study metallurgy, he soon gets an idea of the very marked non-homogeniety of metals. Books on machine design, and engineers' handbooks give tables of strength values for materials which may be used with the standard formulas and enable fairly satisfactory design work to be done, by the use of a large factor of safety (factor of uncertainty would be a better term), but if it is attempted to apply the common formulas of design to very small areas under high stress they cease to be satisfactory.

Moreover any information about materials given to a college student will probably be out of date by the time he is in a position to do independent work in machine design in practice.

* Delivered at the Summer School for Engineering Teachers, Purdue University, July 6, 1929.

How many of even the younger instructors in machine design in their college courses were given any quantitative information about the strength of autogeneous welds in steel, about the strength of aluminum alloys, about the actual strength of shafts of case carburized and heat-treated steel? The student now studying machine design will probably need to know in their practice the strength properties of nitrided steel, of bakelite and other similar compounds, of magnesium alloys, and possibly of beryllium. If all the study a student gives to materials merely gives him information about the properties of materials commonly used at the time he is a college student, it is doubtful whether the study of materials is justified as a regular part of the curriculum.

The Uncoordinated Science of Materials. If the student is to gain some skill in really scientific analysis of the problems of choosing materials for machine parts and in determining proper sizes and shapes for such parts, the teacher must coordinate for him a number of fields of study which today are regarded as almost independent. Metallography, mathematical analysis of stress and strain, properties and behavior of timber, rubber and textiles, the action of "cementing" materials, patterns of atomic arrangement and their significance—all these fields of study today touch the practical problems of the user of materials. The Newton who can give a coherent picture of this chaotic aggregation of practical facts has not yet appeared.

One thing can be done: the student can be given training in using the various sources of information about materials so that when in later years he needs information about materials he will not turn to the out-of-date constants of his college days, but will have some intelligent idea of where to look for up-to-date information, and of how to judge of its reliability.

II. Source of Information Concerning Materials.

"Experience." Machine designers will always be dependent to a large extent on the experience of manufacturers of machinery and of the men in the shops who have to fabricate

the materials or use the finished machine. No definite rules either for gaining experience with materials or for using such experience can be given. However, the designer should always be encouraged to keep in contact with the shop men and with the service records of machines. In the classroom work in machine design it seems to the speaker that it is highly desirable that the student should always be required to think of shop, the erecting floor, and the user.

However, experience is a very unsatisfactory guide for the choice of a new material. We have a large body of experience concerning the service of riveted joints. We have a comparatively very small body of experience concerning the service of welded joints. The uncertainty as to the reliability of welded joints is an excellent illustration of how much we need experience, and how little experience with one type of metal can be transferred when we have to consider a new type of metal.

Direct Experimentation on the Properties of Materials. Some of the large firms are equipped with testing departments so that they can make laboratory studies of the properties of new materials or of new grades of old materials, and can determine the properties of such materials for themselves. In general, this is not the case for small firms. A few tests of samples of a new material does not constitute a satisfactory investigation. Adequate laboratory investigation of new materials though speedier than gaining experience, is costly and rather slow. In general, the machine designer will have to take the results of such laboratory investigation at second hand from other sources than the laboratories of his own firm.

Handbooks and Textbooks. Machine designers depend very largely upon material in handbooks and textbooks for their information as to the properties of materials. The student in machine design should be taught to use such material discriminatingly, looking always for the source from which the information was obtained, for the date at which the information was obtained, and for the details of composition and treatment of the material. For example, a statement as to the strength of 0.40% carbon steel is entirely meaningless unless

we know the mechanical and heat treatment to which the steel has been subjected.

Information in handbooks and textbooks is usually at least six months old when the books are published. After such a book has been used for several years, inevitably there are many subsequently discovered facts about materials. For instance, none of the handbooks or textbooks with which the speaker is familiar would give the machine designer any adequate information about the strength of case-carburized material. The student of machine design should be taught to use the statements in his handbooks, but not to regard them as statements of final fixed truth, and always to be on the lookout for later material.

The Technical Press. The technical press gives more up-to-date data about materials than do handbooks and textbooks. On the other hand, the technical press frequently is somewhat over-enthusiastic about new materials. The student of machine design should certainly be taught to use the technical press, but he should also be taught to examine its statements critically, and to discriminate between the account of a new material just produced which is expected to give marvelous results and the account which quotes laboratory tests or service records showing the service properties of the material.

Of late years the speaker has found that one of his most serious professional mistakes has been the failure to keep up his reading of German. A great deal of valuable information concerning the newer materials is available in German many months before it is available in English.

Proceedings of Technical Societies. Probably the information concerning materials in the proceedings of technical societies is not quite so up-to-date as the materials in the technical press. On the other hand, papers before technical societies and the discussion of them do give a better balanced picture of the possibilities and limitations of new materials than do the articles of the technical press. Students of machine design should be encouraged to study the proceedings of technical societies and to study the discussion of papers as closely as they do the papers.

Advertising Material. If used discriminatingly much information can be obtained from the advertising material put out by the manufacturers of materials. Of course, in using such material an *extremely* critical attitude is necessary. The ethics of advertising have greatly improved in the past decade or two, but the code of ethics scarcely requires an advertiser to emphasize all the bad features of his product, nor does it require him to speak modestly of the good features. Advertising material should be regarded as giving suggestions worthy of more careful study rather than of giving information of a strictly technical character.

The foregoing paragraphs have all been written on the general principle that the problem of the teacher of engineering materials is much less to give the students *information* as to the specific properties of materials than it is to tell them the sources of such information and to fill them with a spirit of intelligent criticism of such information as they have to obtain second hand. We can not hope to give our students in machine design much information about materials which will be worth very much after they have been out, say, five years, but we can hope to give them habits of study and to show them where information may be obtained and how its value may be estimated.

III. Some "General Principles" for the Study of Materials

Significant Properties of Materials. The discussion of significance of various properties which are found for materials by mechanical tests, chemical analysis, microscopic examination, and X-ray analysis certainly is a discussion of "general" principles for materials, as is the study of the general significance of heat treatment, mechanical treatment, removal of moisture and protection against corrosion.

Uniformity and Reliability of Materials. How does the uniformity and reliability of natural products, such as building stone and timber, compare with analogous properties of artificial products like the metals and concrete? What effect on reliability of a material has the development of a stand-

ardized and accepted code of testing? How is the reliability of a material affected by the care and precision which are used in testing that material? What are the types of inherent defects found in different materials? How serious are these defects? What effect do they have on "the factor of safety?" What is the range of variation in quality to be expected in various metals? What is the effect of *time* on the strength and reliability of various materials? These are a few of the questions which may be asked in the endeavor to get at general principles of reliability and uniformity of materials.

How shall we Teach "General Principles?" The idea of studying broad general principles, and then with those broad general principles thoroughly assimilated and firmly fixed in the mind, applying them to special cases is a very attractive idea. However, in the opinion of the speaker it very rarely works. When the ordinary good American student has to learn abstract ideas before he learns specific uses of those ideas, about the best he does is to memorize statements of those abstract general principles, and to apply them timidly, clumsily, and inaccurately. The speaker believes that this attempt to teach abstract general principles too early is the source of a good deal of engineering students' troubles with mathematics and physics. Much of the material taught in those two subjects would be of much more significance to the student *after* he had studied mechanics of materials (with laboratory), heat engines, and electrical laboratory. Hower, all that is another story.

The speaker has referred to the study of materials as the study of an uncorrelated science. The study of materials resembles more closely in its general content the study of biology than it does the study of modern physics. In modern physics mathematical analysis dominates theory and experiment, in biology mathematical analysis is slowly coming into use to help interpret the great mass of observational data. Such is largely the case with materials. To be sure, we have the mathematical theory of elasticity, but that does not begin to tell us all we need to know about materials, and, moreover, it is coming to be recognized as a "statistical" method of

analysis of the behavior of materials under load rather than as an exact statement of law.

As in biology the best method of study has been found to be the immediate association of any principle studied with an observational study of actual plants or animals, so the speaker believes that in materials the best method will be to associate any statement of principle directly with observation, or discussion, of the behavior of definite materials.

We desire to teach general principles in materials as in every other study, but we must remember that the vast majority of students learn *from definite examples to general principles* rather than by the reverse process.

The "case" method has been found excellent in teaching law. Most problems in machine design furnish good "cases" for the study of the behavior of materials.

IV. Methods of Teaching Materials

Should There be a Special Course in Materials?" In some engineering schools a special course in materials is given; sometimes the course in materials testing laboratory is given in connection with this course. In other schools the properties of materials are discussed in connection with the course in engineering mechanics, the courses in machine design, or the shop courses. There is certainly a sufficient "body of knowledge" and a sufficient importance to the engineering profession to justify a separate course in materials, but the same might be said of many other subjects for which no room can be found in our crowded courses of study. Materials, taught in connection with the other courses named above, is likely to be taught superficially, and in homoeopathic doses. The speaker doubts the wisdom of burdening a planned course with the duty of giving isolated bits of information about subjects "about which the student ought to know something." Newton, the Bernoullis and Hooke could speak intelligently and informingly about practically any field of knowledge of their day. We do not expect that of Einstein, A. A. Noyes, or Osborn. If materials can not be given enough time (either in a separate course or in a course in mechanics or machine

design) to be well taught, it is, in the opinion of the speaker, better not to try to teach it in a formal way.

A possible solution is the giving of an elective course in materials, open to advanced students. This plan has worked very well at the University of Illinois.

Lectures in Materials. The speaker has had experience with lecture courses in materials at three universities; in all three the lecture courses were unsatisfactory. For American students occasional lectures may be justified as enthusiasm arousers, but they are very ineffective as a means either of transmitting definite knowledge or of giving a real grasp of general principles. Most of the information about materials and the careful statement of such general principles as there are can, in general, be given better by the printed page than by word of mouth.

Textbook and Recitation Courses in Materials. This method offers greater possibilities than the lecture method. It is especially suitable as the method for an advanced elective course. In such a course the instructor should try to do more than to require the temporary memorizing of *facts* about materials in current use. "Why do we use castiron for scale levers but not for crane hooks?" "What other materials can be used for railway ties in place of wood?" "Why may the extra cost of alloy steel be justified in locomotive side rods, but not justified in ordinary structural members?" "Would you use alloy steel for a lathe spindle?" Questions of this character might well be discussed. Moreover, the instructor will do well to emphasize the fact that the future will see the development of new materials and new treatments for old materials, and will warn the students against regarding the specific values given in the texts and handbooks of their school days as being of much direct value in later years.

Laboratory-Recitation Courses in Materials. Laboratory courses in any subject without accompanying recitations or discussions are very likely to become mere training courses in the art of handling apparatus and reducing data according to a standard system. This is not without use, but misses the objective of teaching "general principles." Laboratory *com-*

bined with discussion and recitation is perhaps the ideal way to teach materials, but it is costly, both in students' time and in actual expenditure on apparatus, specimens, and instructors' salaries. It is the opinion of the speaker that where feasible such a combination course would be the best means of giving the engineering student a worth-while knowledge of the general principles of "materials."

TRAINING OF DESIGNERS—METHODS OF TRAINING *

By S. W. DUDLEY

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In the following paper an attempt has been made to summarize some of the most important considerations relating to methods of training in the field of engineering design. At the outset, may I acknowledge my indebtedness to Professor E. O. Waters, in charge of courses in this field in the Department of Mechanical Engineering at Yale, for valuable suggestions based upon many years of successful application of the principles herein discussed.

Time does not permit elaboration of many of the factors relating to this topic. For the most part this would be unnecessary. Many such factors that might be included for the sake of completeness would be recognized and agreed upon, both from the educational and the professional viewpoint. But there are some features of the problem to which attention may well be directed.

A generation ago skill in the technique of draftsmanship constituted the major objective of courses in this field. Modern organization in industry sharply distinguishes between the functions of the inventor, the designer and the draftsman.

The **Inventor,** usually a non-conformist, often a radical, perhaps even a revolutionist, works in the borderland, or even beyond the boundaries of standards or of codified knowledge. Not infrequently, his invention precedes perception of the scientific basis upon which its success depends.

The **Designer** must be a conformist. He may be liberal or conservative, but he must work reasonably within the limitations of approved methods.

* Delivered at the Summer School for Engineering Teachers, Purdue University, July 15, 1929.

The **Draftsman,** skilled in the technique of the art, completes the details of the general plans and specifications developed by the designer and prepares them in a form suitable for the various branches of the industry.

In many cases the same individual performs all three functions, but for the present purposes the designer alone is considered.

It is realized, of course, that no formal educational program within the usual limits of the four, or even six-year period, can train men to be designers, any more than the entire curriculum can train them to be mechanical engineers. But it can and should adequately prepare them to *become* designers.

Any method of training designers, to be successful, must lead to the acquisition of knowledge adequate in both quality and quantity. This acquisition of knowledge, as Loewenstein so aptly says in his preface to Stodola's "Steam and Gas Turbines," passes through two stages:

> "The first, related to inventive thinking, consists of the intuitive grasping of the conditions as a whole, while the second has for its purpose the exact numerical determination of the relations. . . . Here begins a danger which it is the teacher's duty to point out. . . . If we burden ourselves with too many refinements of the theory of functions, the free outlook is covered as with a dark cloud. . . . The thorough investigation of *the existing,* laudable in itself, becomes the main purpose; and technical progress vanished from the field of vision. We remain rooted in the toils of an unsolvable differential equation, while around us life is advancing and the seeds of new inventions are sprouting. There is *a destructive but irresistible property of mathematical symbols which permits one to use and work with them without having to do any thinking.* Counteracting this pedagogical danger is one of the main problems of higher education and of self-education."

Engineering design calls for the focusing and the synthesis of other branches of knowledge upon a concrete task. It draws upon experience, skill and judgment without limit. The period of acquisition and training is therefore continuous.

While systematic drill in the processes of analysis and syn-

thesis, in the sense of the usual textbook treatments of the sciences may not be feasible, design courses should call particular attention to the difference between solving a given problem and the task of the designer.

He is confronted with a situation. It involves all sorts of factors. From these he must formulate his problem and carefully scrutinize and check his conclusions in the light of the best information and critical judgment at his command. Then, and only then, may he safely attempt a symbolic or mathematical statement or proceed to a solution. This calls for a different type of training than that of most other courses. Directed experience perhaps more aptly expresses the process than does training, for only by trial and personal experience can correct habits and skill in these directions be acquired.

The average student, in most of his pre-design courses, has encountered principles or demonstrations to be learned, or definitely stated problems to be solved. He has acquired more or less automatic memory responses. The word *force* may mean to him an arrow, or possibly Ma—he is not too sure what M is, but if not questioned too closely, he is apt to remember that he can use in its place W/g and life begins to appear much simpler, for the data of the problem can then be substituted in the formula and by manipulation an answer obtained.

Ingenious and devious as he may be in the handling of stated problems, in design courses his training and experience should be organized from the point of view of the physical and other factors involved, the conditions existing, and the requirements, stated or to be discovered. These demand action of some sort. The factors, the situation, the existing conditions, must first be studied and analyzed before the specific problem, or problems, involved can be formulated. Essential factors must be distinguished from non-essential. Familiarity with principles and relationships applicable to the case in hand handicaps rather than helps unless reinforced by discrimination between the significant and the immaterial. Professor L. P. Breckenridge, used to remind his students frequently of a constant factor invariably omitted from all formulas by writers of textbooks, the factor J standing for *judg-*

ment. "Formulas," says Unwin, "save the designer the trouble of thinking," but I would like to add that this is only after their adequacy for the case in hand has been thoroughly established. Consequently, they are quite secondary in importance.

The demand upon the schools is vigorously expressed by Mr. John C. Parker, Vice-President in Charge of Engineering, Brooklyn Edison Company, in his stimulating article, "Wanted: An Unpractical Education," published in the *Journal of Engineering Education* for February, 1929. I venture to recall to your minds the trend of his thesis by quoting a portion especially pertinent to our present discussion.

> "Practical design concerns itself with intricately organized social and economic processes. The most trifling engineering device must be designed for production under the peculiar conditions and restraints of an actual factory, to be marketed through real and frail human channels and to be used by actual ultimate consumers. Ninety percent of the problem of a designer lies in the wise determination of these and other constraining facts in the selection of the field which he shall endeavor to cover, and in the satisfaction of others that his determinations are sound. His work is primarily in the discovery and statement of his problem. No school can ever hope even remotely to assemble an environment of actuality about any problem. Of necessity, it must formalize an artificial problem if indeed it would avoid giving the student a most impractical impression that his subsequent problems in actual life will come to him all neatly wrapped up in a package, labeled and classified."
>
> "None of the world's great discoveries and inventions has come by the process of yielding up, like a squeezed sponge, those things which the mind has soaked up, but rather, as the result of critical and creative and impatient mentalities.
>
> "What little of practical training may be necessary can very quickly be grasped by a young man fundamentally and thoroughly educated—through his contacts in the only school of practice—life itself. Schools should have more faith in education and less compliance in giving functional training."

Once introduced to the process of analyzing the factors in a given situation and by synthesis arriving at a formulation of the specific problem arising from these circumstances, the student's interest is usually aroused and the quality and quantity of his work improved accordingly. The process can easily be overdone. It is a new experience and an unfamiliar point of view. The first steps must be short and simple, but carefully directed and well placed. A few simple, illustrative cases thoroughly mastered are better than a more impressive number of projects completed by means of much aid and specific direction from the instructor.

If the first steps are made simple and clear, the mistakes which will inevitably occur, instead of being permitted to appear as stumbling blocks, may be utilized as stepping stones to improvement.

Careless mistakes, usually evidences of an enthusiastic temperament or slovenly habits, call for censure; mistakes of reasoning are to be censured, corrected, and avoided in the future; mistakes due to ignorance are to be corrected, not censured, but used as object lessons to illustrate the importance of thorough knowledge, experience and analytical reasoning. Mistakes also indicate the importance of care in drafting and checking, whereby such errors may be detected and corrected before great expense and delay become involved.

When presented with these considerations always in mind, the courses in engineering design, instead of being of a routine, detail character, should be exactly the opposite. They focus and give vitality and meaning to the fundamental and technical courses. They demand mental alertness, patience, thoroughness, accuracy of analysis and resourcefulness. They exact a heavy tax from those who are lazy, indifferent, or lacking in judgment or common sense. But these are all qualities which will have a determining influence upon future progress in this field, and if the student is headed in the wrong direction, the sooner it becomes known the better for all concerned.

For this reason the question of who should take such courses is a fair one. All mechanical engineering students certainly should have the preparatory general courses in the fundamen-

tals of drawing and machine design. Many elect the mechanical engineering course, however, who are headed very definitely toward a career far removed from engineering design. While courses in the subject would undoubtedly benefit such men, other courses, more in line with their interests and aims, may be of equal value. There are advantages to the student, and to the effective handling of the course, in making design courses elective, open to students properly qualified both within and without the department.

The method suggested demands intensive application on the part of both instructor and student, but the building of any foundation is no light task. Sound engineering judgment and the ability to criticise intelligently and constructively one's own work or the work of others, while a matter of slow growth and development through experience, can be guided and checked by systematic planning and wise direction.

It is toward these objectives, rather than towards skill or vocational competency in any specialty, that the profession makes its most urgent demands upon the schools.

TRAINING OF DESIGNERS—QUALITIES THEY SHOULD POSSESS *

By HENRY F. SCHMIDT

Consulting Engineer, Westinghouse Electric and Manufacturing Company

The attribute most necessary for a designer to have is love of his work, as this will enable him to study and work out details. Unless a designer has this, the minor details, frequently involving considerable labor, will suffer.

Students desiring to take an engineering course should be studied as to their natural inclination toward the work, for, unless born with a mechanical aptitude, they will be more successful elsewhere. Not infrequently, men who have stood high in their classes are misfits in an engineering organization because they entirely lack those mechanical instincts which cannot be developed if the seed is not there.

Next in importance to love of the work is health, as without good physical health and early-formed habits which tend to maintain good health, a man is not able to give the concentrated effort that is required.

Mental alertness and the ability to grasp problems readily are valuable, although some very good designers are not very quick in grasping the problem to be solved.

Judgment and the ability to weigh the results of calculations and to determine by direct reasoning whether an answer arrived at mathematically is logical, are very essential. Judgment also enters into design problems in many forms, but this can be developed only by experience and cannot be acquired in college.

Originality is a desirable characteristic for a designer, but it is not imperative, except to a limited degree. Originality and inventiveness are closely allied, and in the course of the

* Presented at the Summer School for Engineering Teachers, Purdue University, July 15, 1929.

day's work, a good designer will originate many things, although most of them will not be patentable.

In this connection it should be borne in mind that originality and inventiveness are sometimes stressed to the point where they are made an end in themselves, rather than the means of obtaining a good design. The mere fact that something is different or new does not necessarily make it a good design. Sometimes there is a tendency on the part of the designer to concentrate on originating some scheme of his own, rather than on solving the problem which has been assigned to him.

Generally speaking, designs which are new and different from those previously employed are highly desirable, provided, however, they perform the required functions more efficiently and cheaper. The copying of designs and substituting new values to meet the requirements of a particular job, should be discouraged as much as possible, because, frequently, what is considered good practice based on past experience is far from the best. Because a certain part or piece of apparatus has been made the same way for thirty or fifty years is all the more reason for suspecting that other and simpler designs are possible. Some respect for, but not veneration of, old "standard" designs should be instilled in the student.

One trait which prospective designers should have developed to a high degree is that of patience, for it not infrequently happens that a design for a machine may be substantially completed, when either through invention of some different way of accomplishing the desired results, it may be desirable to begin all over again. In fact, experience shows that several successive designs will be completed or nearly so before one is finally accepted. There are many designers who do not seem to be able to adjust themselves to this condition and become discouraged because the first or second design is not accepted and built. There are many elements, of course, which enter into the making of what is called the best design, because not only theoretical and mechanical conditions must be met, but the designs must also be worked out in such a manner that

they will lend themselves to economical production. Often, more or less unreasonable ideas of the purchaser must be included in the design.

Intelligent obedience is a highly desirable characteristic. Many designers find it difficult to do what they are told; others do exactly what they are told without protest even if it is obviously wrong or impossible. Designers should be taught to realize that the engineers directing the work have many problems on their minds aside from a single design and frequently do not perceive all the minor details as clearly as the man actually working on it. Where there is an obvious error in design or construction, which may have been suggested by the engineer in charge of design, the designer should point this out at the time.

One of the commonest shortcomings of designers is lack of knowledge of the fundamental principles of mechanics, physics, mechanics of materials, and similar subjects which enter into design work. A thorough knowledge of the fundamental principles of mechanics is far more important than a knowledge of higher mathematics, and it is strange that the lack of knowledge of fundamentals is frequently found among men who have had the best mathematical training. Often we find that a man's knowledge of mathematics is of no avail because he is unable to use his mathematics through lack of familiarity with the fundamentals required.

Training

Experience indicates that one of the most serious shortcomings of practically all engineering graduates is their lack of a classical background. I believe that before a course in engineering is entered upon, a fairly thorough course in English composition and languages, particularly French, German, and possibly Spanish, should be taken.

Debating and public speaking should also be included, for sooner or later, a designer or engineer will be required to speak in public, or at least to sell an idea to the board of directors.

Engineering reports almost universally show an insufficient

knowledge of English composition, and not infrequently reports are so poorly written that valuable engineering information is almost lost or is rendered of little value. Further, the study of English composition serves as a valuable training for the clear expression of engineering conceptions, and without the ability clearly to state one's thoughts, it is not possible to have clear, logical, consecutive thoughts.

One of the most commonly used expressions is "I know perfectly well what I mean but I can't say it." This is largely untrue because if thoughts are entirely clear in one's mind, they can usually be expressed, although insufficient knowledge of English may be a severe hindrance in setting down one's thoughts.

Debating seems far removed from engineering; still the ability clearly to present one's arguments is of valuable assistance when one is compelled to argue the merits of one design over another. It not infrequently happens that the man backing an inferior design will have it accepted simply because of his ability to debate its merits and present them to the best advantage.

In connection with English composition, attention may be drawn to the fact that the average engineer suffers considerably because of the rather limited vocabulary acquired in the ordinary engineering courses.

Mathematics is, in a measure, the mainstay of engineering. This subject should be extended sufficiently to include quite a thorough study of harmonic analysis, and throughout the various stages leading up to and including harmonic analysis, great stress should be laid on mathematics in its applied forms. One of the commonest failings of engineering graduates is that they have learned considerable mathematics and do not know what to do with it. That is, if some one sets down a problem in engineering in the form of a formula involving higher mathematics, they can go through the processes of solving it, but when given a problem, are unable to set it down in mathematical form. Sometimes a man with mathematical knowledge not extending beyond high school algebra

can accomplish much more than his mathematical superiors through his ability to formulate the problem.

Analytical mechanics, including hydrostatics and hydrodynamics, should receive special attention and should be carried through at least three years of the engineering courses instead of one year, as at present. The courses in analytical mechanics and hydrostatics should include practical applications of the fundamental laws, with sufficient repetition to impress them indelibly on the student. The most frequent errors in design are caused by a seeming lack of knowledge of the more elementary laws of mechanics and the inability to use these laws in reasoning out problems.

More detailed study should be devoted to hydrodynamical theory, treating on the distribution of pressure in oil films, bearing design, losses, etc.

As an example of failure to apply the principles of elementary hydrostatics, the writer was recently called upon to settle a dispute between seven of the younger engineers as to the force exerted on a "Sylphon" bellows by a given internal pressure. Four of the engineers claimed that the pressure acted upon the mean diameter of the bellows; two said the inside diameter, and one said the outside diameter. One out of seven is not a high average!

If a college course were limited to but one subject, the writer would unhesitatingly select a very thorough course in physics. The frequency for which the knowledge of light, sound, etc., not covered by other special subjects, is of value and occurs in engineering problems is surprising, and the little knowledge of these subjects which has been picked up in a general course in physics is all that the average engineer has to depend upon. The course in physics should be much expanded, especially the laboratory work. This work also familiarizes the student with methods of attack on seemingly unapproachable problems, and for this reason is of the greatest value in all branches of engineering.

A more extended training in dimensional reasoning should be included, as this frequently provides the easiest method for deriving the general form of an equation. It is not unusual

to find such a formula as that for the head created by a backward-curved-vane centrifugal pump which dimensional analysis shows to be of the order of an area or volume instead of length as it should be.

This calls attention to the general evil of using formulas from handbooks in design work.

It should be impressed upon the student that he should never use a formula unless he is familiar with its origin. Also, when it is absolutely necessary to use a formula he should check it dimensionally to determine whether it is of the correct general form. However, occasionally for use within limits a formula may be employed in which certain terms are insignificant within the prescribed limits. In such cases, due to the omission of terms, it is possible that the formula, while not being strictly mathematically correct may serve a useful purpose. Without knowing the derivation, origin, limits and the authority, formulas found in handbooks are dangerous and often the cause of serious mistakes.

The present courses in thermodynamics seem quite adequate, but greater stress should be laid on the transmission of heat, as in boilers, condensers, heat exchangers, etc. Though in a sense not part of thermodynamics, the theory of combustion of liquids and solids should have more attention.

Although generally taken as a part of a course on steam turbines, the application of thermodynamics to the problems of flow in turbines should receive careful study. The present extensive courses on steam turbines given in some schools might well be omitted. There is so little in textbooks that is of actual service in the design of turbines, that the time thus devoted might better be spent on fundamentals.

Mechanics of materials should receive special attention, both from the theoretical and laboratory standpoints. The subjects of fatigue, creep, effects of high temperatures and internal distribution of stresses should be gone into much more thoroughly than has been done in the past. These subjects are of ever-increasing importance, as materials are constantly being worked at higher stresses under a greater variety of conditions than formerly.

Metallurgy, including the study of methods of production of ferrous and non-ferrous materials, should receive an ever-increasing share of the student's attention. Intelligent use of materials can be made only when the engineer is not only familiar with the materials and their mechanical characteristics, but likewise with methods of manufacture. More time should be given to practical work in the foundry and machine shop than heretofore. This is particularly true for engineers intending to specialize on machine design. A thorough knowledge of foundry methods by actual experience and familiarity with the methods of making moulds and what can or cannot be moulded is absolutely essential, in order to avoid producing designs which the shop cannot make or which can be produced only at great expense.

Machine-shop experience serves the same purpose. It should be impressed on students intending to enter design work, that in addition to working out a design which is correct from a theoretical standpoint and which fulfills the desired requirements, it is necessary for the designer to visualize all the operations of the foundry and the machine shop necessary for its production. That is, he should mentally mould, cast, machine, erect, and test the apparatus being designed. Occasionally, it is necessary or desirable to make a design which cannot be produced by any of the present methods or tools. Such a design is entirley justifiable in the case of quantity production, but in such cases the designer also must be able to design the necessary tools or describe methods for its production. In other words, inventing something which is new and different and which cannot be produced by any present methods, is useless unless the inventor can also devise the necessary tools.

The study of turbines, engines, pumps, etc., could be eliminated almost entirely without any loss to the student. The practice of studying various turbine, engine and boiler designs in detail is quite useless and should be discouraged for the reason that the designs and descriptions that find their way into textbooks, and even into catalogues, have generally grown obsolete during the time required for publication.

Further, studying detailed designs of machines has a great tendency to create in the student a habit of copying rather than one of originating. Copying is probably the cause of more errors and field troubles with machines than anything else. As a matter of fact, the principal object in studying designs is to learn what to avoid rather than to see models from which to copy.

It would be well for engineering students, and engineers as well, to use a paraphrase from Kipling's "If" for a motto:

> "Let all books count with you,
> But none too much,"

for there is too much of a tendency to believe that if you see anything in a book, it must be so. This also applies to the journals of engineering societies. Students should be taught that, to a great extent, papers presented before engineering societies give some one aspect of a subject, not too infrequently tinged to suit the author's own ends or to present some process apparatus or new invention in rather more than a favorable light. Data taken from society journals should be carefully scrutinized to insure that they were not obtained in a manner intended to promote some particular object.

Students now being graduated have far more self-confidence than those of ten or twenty years ago. This is a good sign. Self-confidence based upon a thorough knowledge of fundamental laws should be instilled in the student, but not merely on the fact that he has been through college. He should be taught to reason out problems step by step to the conclusion, make absolutely sure he is right, and then defend the conclusion against all opposition: professors, books, engineers. Gray hair, titles, and printer's ink are not guarantees of great wisdom or infallibility.

In conclusion, I desire to call attention to the benefits to be derived from frequent observational trips through as great a variety of shops and industries as possible, and more particularly, those which are not related to the student's special line of work. It is believed that practically all engineers who

have practised for a number of years have found that the most valuable knowledge they have is that which they have picked up on subjects not directly connected with their work.

The writer believes, finally, there is a marked improvement noticeable in the standard of technical training of students graduated during the last few years.

EDISON MEDAL AWARDED TO CHARLES F. SCOTT

The Edison Medal of the American Institute of Electrical Engineers has been awarded to Professor Charles F. Scott, New Haven, Conn., "for his contributions to the science and art of polyphase transmission of electrical energy."

The Edison Medal was founded by associates and friends of Mr. Thomas A. Edison, and is awarded annually for "meritorious achievement in electrical science, electrical engineering, or the electrical arts," by a committee consisting of twenty-four members of the American Institute of Electrical Engineers.

Professor Scott now an Honorary Member of the American Institute of Electrical Engineers, has been a member since 1892, and was President during the year 1902–03. He had previously served as Manager 1895–98 and Vice-President 1899–1901. He has served many Institute committees, and is at present a member of the Lamme Medal, and Student Branches Committees, and representative on the Commission of Washington Award and The American Engineering Council.

As President of the Society for the Promotion of Engineering Education (1921–23), Professor Scott proposed a serious consideration of methods of improving the teaching of engineering. His efforts led the Society to undertake an investigation of what it could do "to develop, broaden and enrich Engineering Education." He has served as Chairman of the Board of Investigation and Coordination in this notable undertaking in which there has been active cooperation of engineering schools, engineering societies and industry, and which has instituted the Summer School for engineering teachers as one means of improving engineering education.

In addition to his memberships and offices mentioned above, Professor Scott is a member of the American Society of Mechanical Engineers, National Electric Light Association, Illuminating Engineering Society, American Philosophical Society, and Engineers' Society of Western Pennsylvania (Past President). He has received the following honorary degrees: M.A., Yale University; Sc.D., University of Pittsburgh; and Eng.D., Stevens Institute of Technology.

INTERNATIONAL CONFERENCE OF TECHNICAL EXPERTS IN THE PRINTING INDUSTRY

The International Conference of Technical Experts in the Printing Industry on the Need for Research was called by the Executive Committee of the Printing Industries Division of the American Society of Mechanical Engineers to meet at the Carnegie Institute of Technology, Nov. 7 and 8, 1929.

The S. P. E. E. was one of the twenty-six national organizations participating together with a number of representatives from foreign countries.

It was apparent throughout the conference that there is a growing realization of the need for engineers in the printing industry.

Many technical and engineering problems to be met were enumerated, and it was amazing to note the differences of *opinion* as to what is or is not possible, thus emphasizing the absence of *facts* which might be determined by the engineer.

Past and present actual achievements in the printing industry as a result of engineering attack and research were in evidence.

A need was apparent for a closer cooperation of related and inter-related industries in solving mutual engineering and technical problems through their respective organizations.

The culmination of the Conference was a decision to create a graphic arts research foundation. A Ways and Means Committee was appointed.

A. C. JEWETT,
R. H. SPAHR,
Representing the S. P. E. E.

1929–30 MEMBERSHIP CAMPAIGN

On September 13 the Secretary wrote to the representative of the Society in each institution in the United States and Canada asking him to send to this office the names of all members of the engineering faculty. On this list the Secretary marked off the names of those persons who were members of the Society and to the others he sent invitations for them to join the Society enclosing an application blank for that purpose. The names of the faculty members of the following institutions were received.

On January 6 when this notice was sent to the printer invitations had been sent to 1,484 persons as indicated on the table. 154 applications have been received to date.

The Secretary asks you to seek the men in your institution who are not members of the Society and to second the invitation which he has extended. If your institution is not listed here, ask your local representative for the reason. We are printing an application blank herewith for the convenience of those who may not have any available.

F. L. BISHOP,
Secretary.

Institution	Application Blanks Sent	Applications Received	Members
Akron, Univ. of	3	0	9
Alabama Poly. Inst	15	3	13
Alabama, Univ. of	13	0	1
Alberta, Univ. of	0	1	3
Antioch College	6	1	5
Arizona, Univ. of	0	0	9
Arkansas, Univ. of	7	0	7
Armour Inst. Tech	22	1	23
Beirut, Univ. of (Syria)	0	1	1
Bombay C. E. College	0	0	1
Bradley Poly. Inst	0	0	2
Brazil-Poly. School of State	0	1	1
British Columbia, Univ. of	0	0	4
Brooklyn Poly. Inst	0	0	18
Brown Univ	0	0	8
Bucknell Univ	10	0	10
Buffalo, Univ. of	0	0	1
Calif. Inst. Tech	26	0	7
Calif., Univ. of	0	0	8
Calif., Univ. of So	0	0	5
Carnegie Inst. of Tech	39	0	21
Case School Applied Science	12	3	29
Catholic Univ	0	0	1

Institution	Application Blanks Sent	Applications Received	Member
Chicago, Univ. of	0	0	1
Cincinnati, Univ. of	33	0	7
Clarkson College	0	0	5
Clemson College	0	2	8
Colby College	0	0	1
Colorado Agri. College	13	0	5
Colorado School Mines	37	0	10
Columbia University	27	4	25
Colorado, Univ. of	29	4	20
Cooper Union	0	1	13
Cornell University	71	4	27
Cornell College	0	0	1
Dartmouth College	0	0	4
Dayton, Univ. of	0	1	5
Delaware, Univ. of	0	0	8
Denison Univ	0	0	2
Detroit University	12	3	11
Drexel Institute	31	3	7
Duke Univ	0	0	9
Ecole Polytechnique	28	1	2
Evansville College	0	1	2
Florida, Univ. of	13	0	11
Franklin and Marshall College	0	0	2
Franklin Union	0	0	2
General Motors Inst	0	0	3
George Washington Univ	0	0	2
Georgia Inst. of Tech	41	1	19
Gettysburg College	0	0	2
Girard College	0	0	1
Harvard University	14	1	13
Haverford College	0	0	1
Hawaii, Univ. of	4	0	2
Howard Univ	0	0	1
Idaho, Univ. of	11	5	12
Illinois, Univ. of	32	3	52
Indiana Univ	0	0	1
Iowa State College	67	2	31
Iowa State University	5	2	23
James Millikan Univ	0	0	2
Johns Hopkins Univ	0	0	2
Kansas State Agri. College	62	11	39
Kansas, Univ. of	31	0	23
Kentucky, Univ. of	0	1	12
Lafayette College	3	1	11
Lehigh Univ	0	0	17
Leningrad Poly. Inst.	0	0	1
Lewis Inst	0	0	1
La. Industrial Inst	0	0	3
La. Southwestern Inst	0	0	3
La. State Univ	0	0	2
Louisville, Univ. of	5	0	12
Maine, Univ. of	14	0	23
Manhattan College	0	0	7
Marquette Univ	0	0	5
Maryland, Univ. of	0	0	2

Institution	Application Blanks Sent	Applications Received	Members
Mass. Agri. College	0	0	1
Mass. Inst. Tech.	0	1	43
McGill Univ.	0	1	9
Mechanics Inst.	0	0	2
Mexico, Univ. of	0	0	4
Michigan College Mines	16	0	6
Michigan, Univ. of	77	5	48
Michigan State College	0	1	12
Minnesota, Univ. of	39	2	75
Mississippi A. & M.	12	0	4
Mississippi, Univ. of	10	0	3
Missouri School Mines	19	2	12
Missouri, Univ. of	6	0	16
Montana School of Mines	0	0	2
Montana State College	0	0	7
Mt. Allison Univ.	0	0	2
Nanking Tech. College	0	0	1
Nebraska, Univ. of	0	0	21
Nevada, Univ. of	18	0	3
Newark College of Eng.	16	1	12
New Hampshire, Univ. of	9	1	10
New Haven College	0	0	1
New Mexico A. & M.	6	0	3
New Mexico School Mines	8	0	1
New Mexico, Univ. of	0	0	3
New York, College of City	0	0	6
New York Univ.	0	0	16
North Carolina State College	0	0	14
North Carolina, Univ. of	0	1	10
North Dakota Agr. College	13	0	4
Northeastern Univ.	0	1	30
Northwestern Univ.	0	0	6
Notre Dame, Univ. of	0	0	2
Norwich Univ.	0	0	4
Nova Scotia Tech. College	8	0	1
Ohio No. Univ.	0	0	3
Ohio Mechanics Inst.	0	0	2
Ohio State University	25	1	56
Oklahoma A. & M.	0	0	9
Oklahoma, Univ. of	23	0	7
Oregon Agr. College	23	4	16
Pei Yeng Univ.	0	0	2
Penna. State College	38	1	37
Penna., Univ. of	0	1	13
Philippines, Univ. of	0	0	1
Pittsburgh, Univ. of	11	2	26
Porto Rico, Univ. of	9	0	3
Pratt Institute	0	8	27
Princeton University	8	2	9
Purdue University	92	5	74
Rensselaer Poly. Inst.	0	0	12
Rhode Island State College	0	0	5
Rice Institute	0	0	4
Rindge Tech. School	0	0	1
Robert College	0	0	1

Institution	Application Blanks Sent	Applications Received	Members
Rochester, Univ. of	0	1	2
Rose Poly. Inst	19	6	8
Royal Military Inst	6	0	0
Rutgers Univ	0	0	10
Saskatchewan, Univ. of	9	0	1
South Dakota School Mines	0	3	8
South Dakota State Coll	6	0	2
South Dakota, Univ. of	0	0	5
Stanford University	23	0	14
Stevens Inst. Tech	12	1	12
St. John's Univ	0	0	1
Swarthmore College	0	1	5
Syracuse Univ	0	0	13
Tangshan Univ	0	0	1
Tennessee, Univ. of	0	0	2
Texas Agri. College	0	0	2
Texas A. & M	45	6	30
Texas College Mines	0	0	1
Texas Tech. College	0	2	8
Texas, Univ. of	25	1	8
Toledo, Univ. of	0	0	3
Toronto, Univ. of	0	0	9
Trinity College	0	0	1
Tufts College	11	0	25
Tulane University	12	0	11
Union College	3	1	9
U. S. Naval Academy	0	2	8
Utah Agri. College	0	0	2
Utah, Univ. of	0	0	5
Vanderbilt University	0	1	6
Vermont, Univ. of	8	1	11
Victoria Jubilee Tech. Inst	0	0	1
Villanova College	0	0	1
Virginia Military Inst	0	0	11
Virginia Poly. Inst	36	2	12
Virginia, Univ. of	0	0	14
Washington State Coll	26	1	10
Washington Univ. (St. Louis)	0	0	9
Washington, Univ. of	0	1	14
Wentworth Institute	0	1	8
West Virginia Univ	0	0	10
Wisconsin, Univ. of	0	3	35
Worcester Poly. Inst	13	2	23
Wyoming, Univ. of	6	1	4
Yale University	0	1	40
Industrial	0	14	
	1,484	154	

Total Membership, December 3, 1929

Individual Members	2,201
Institutional Members	119
	2,320

Return to the Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

Society for the Promotion of Engineering Education

Date.....

THE UNDERSIGNED desiring to become a member of THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

hereby agrees to conform to the requirements of membership, if elected, and submits the following:

STATEMENT OF QUALIFICATIONS

Full Christian Name and Surname.....
Print Last Name First Middle

Mailing Address (Number and Street).....

Post Office (City and State).....

Full Title of Professional Position.....
(Title) (Department)

Full Name of Institution.....

(To be Signed by Two Sponsors)

SPONSORS { .....
.....

* The number of applications requested by their representative.

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BEAN, HAROLD E., Instructor in Pattern Making, Pratt Institute, Brooklyn, N. Y. R. M. Van Gaasbeek, S. S. Edmands.

BEEBE, GORDON A., Assistant Professor of Civil Engineering, South Dakota School of Mines, Rapid City, S. D. Carl G. Watson, E. E. Clark.

BELZ, CHARLES J., Assistant Professor of Civil Engineering, University of Dayton, Dayton, Ohio. B. T. Schad, U. J. Rappel.

BENEDICT, OTIS, JR., Instructor in Foundry Practice, Pratt Institute, Brooklyn, N. Y. S. S. Edmands, J. W. Benley.

BERGEN, HAROLD B., Director, Industrial Relations, The Proctor & Gamble Company, Ivorydale, Ohio. F. L. Bishop, Nell McKenry.

BEYER, EDMOND W., Instructor in Civil Engineering, Union College, Schenectady, N. Y. Hugh Miller, W. C. Taylor.

BOWMAN, HENRY T., Instructor in Mechanical Engineering, University of Pennsylvania, Philadelphia, Pa. Geo. E. Crofoot, Lee N. Gulick.

BRANIGAN, GEORGE F., Instructor in Machine Design, Kansas State Agricultural College, Manhattan, Kans. F. A. Smutz, R. A. Seaton.

BRUNTON, LIONEL J., Instructor in Mechanical Engineering, University of Colorado, Boulder, Colo. H. S. Evans, J. A. Hunter.

BURR, FRANK A., Assistant Professor of Mechanical Engineering, Worcester Polytechnic Institute, Worcester, Mass. C. M. Allen, A. W. French.

CHITTENDEN, HIRAM M., Instructor in Engineering, University of Washington, Seattle, Wash. F. B. Farquharson, E. R. Wilcox.

COWLES, W. H. H., Head, Department of Mathematics and English, Pratt Institute, Brooklyn, N. Y. S. S. Edmands, A. L. Cook.

DAKE, EARL D., Professor of Civil Engineering, South Dakota School of Mines, Rapid City, S. D. E. E. Clark, C. G. Watson.

DAVIS, HALLAM W., Professor and Head, Department of English, Kansas State Agricultural College, Manhattan, Kansas. R. A. Seaton, M. A. Durland.

FILLMORE, HERBERT W., Instructor in Mechanical Engineering, Evansville College, Evansville, Ind. M. B. Robinson, F. L. Bishop.

FREIRE, V. DA SILVA, Professor of Technology of Materials, Polytechnic School of the State, Sao Paulo, Brazil. F. L. Bishop, Nell McKenry.

FRENCH, R. DEL., Professor of Highway and Municipal Engineering, McGill University, Montreal. H. M. MacKay, R. E. Jamieson.

GLENN, HOWARD E., Associate Professor of Civil Engineering Clemson A. & M. College, Clemson College, S. Car. A. L. O'Banion, Sam R. Rhodes.

GRAHAM, EUGENE C., Associate Professor of Shop Practice, Kansas State Agricultural College, Manhattan, Kansas. R. A. Seaton, M. A. Durland.

HERTZLER, ELMER A., Instructor in Mathematics and English, Pratt Institute, Brooklyn N. Y. S. S. Edmands, A. L. Cook.

HUNTER, JAMES W., Instructor in Mechanical Technology, Pratt Institute, Brooklyn, N. Y. S. S. Edmands, Arthur C. Harper.

HYDE, EMMA, Associate Professor of Mathematics, Kansas State Agricultural College, Manhattan, Kansas. R. A. Seaton, C. H. Scholer.

JENSEN, GORDON L., Instructor in Mechanical Engineering, University of Michigan, Ann Arbor, Mich. A. D. Moore, A. H. Lovell.

JONES, ARTHUR S., Assistant Professor of Engineering Drawing, The Pennsylvania State College, State College, Pa. O. K. Harlan, J. O. Keller.

KAMMEYER, JULIUS E., Professor and Head, Department of Economics, Kansas State Agricultural College, Manhattan, Kansas. R. A. Seaton, M. A. Durland.

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KOENITZER, LESTER H., Instructor in Applied Mechanics, Kansas State Agricultural College, Manhattan, Kansas. R. A. Seaton, C. H. Scholer.

MESERVE, GEORGE H., JR., Instructor in Drawing, Northeastern University, Boston, Mass. George B. Gee, Eliot F. Tozer.

MORSE, REED F., Instructor in Civil Engineering, Kansas State Agricultural College, Manhattan, Kansas. R. A. Seaton, W. W. Crawford.

NELSON, DELMAR W., Assistant Professor of Steam and Gas Engineering, University of Wisconsin, Madison, Wis. L. A. Wilson, G. C. Wilson.

OTTER, JOHN V., Instructor in Engineering Drawing, The Ohio State University, Columbus, Ohio. Thos. E. French, O. E. Williams.

PERRYMAN, C. C., Instructor in Engineering Drawing, Texas Technological College, Lubbock, Texas. C. L. Svensen, S. J. Boller.

PICKETT, GERALD, Instructor in Applied Mechanics, Kansas State Agricultural College, Manhattan, Kans. J. H. Robert, R. A. Seaton.

PORSCH, JOHN H., Instructor in Practical Mechanics, Purdue University, Lafayette, Ind. A. A. Potter, J. W. Walters.

QUIER, KENNETH E., Instructor in Mechanical Technology, Pratt Institute, Brooklyn, N. Y. S. S. Edmands, Arthur C. Harper.

ROBINSON, GORDON D., Associate Professor of Electrical Engineering and Physics, U. S. Naval Academy, Annapolis, Md. F. L. Bishop, Nell McKenry.

ROSSELL, HENRY E., Commander, U. S. N.; Head, Department of Mathematics, U. S. Naval Academy, Annapolis, Md. R. I. Rees, A. A. Potter.

SCHERMERHORN, JAMES R., Instructor in Machine Shop Practice, Pratt Institute, Brooklyn, N. Y. S. S. Edmands, John W. Benley.

STOUT, MELVILLE B., Assistant Professor of Electrical Engineering, University of Michigan, Ann Arbor, Mich. A. H. Lovell, H. H. Higbie.

SWEIGERT, RAY L., Assistant Professor of Mechanical Engineering, Georgia School of Technology, Atlanta, Ga. R. S. King, W. V. Dunkin.

TYKOCINER, JOSEPH T., Research Professor of Electrical Engineering, University of Illinois, Urbana, Ill. E. B. Paine, H. A. Brown.

WEAVER, R. R., Educational Director, Western Electric Company, 195 Broadway, New York City. R. I. Rees, Ovid W. Eshbach.

WILLIAMS, DWIGHT, Associate Professor of History and Government, Kansas State Agricultural College, Manhattan, Kansas. R. A. Seaton, M. A. Durland.

WILSON, R. S. L., Dean, Faculty of Applied Science, University of Alberta, Edmonton, Canada. F. L. Bishop, Nell McKenry.

WRIGHT, DONALD H., Instructor in Electrical Technology, Pratt Institute, Brooklyn, N. Y. S. S. Edmands, A. L. Cook.

SECTIONS AND BRANCHES

The Kansas-Nebraska Section held its annual meeting at Lincoln, Nebraska, on November 1 and 2, with the engineering faculty of the University of Nebraska as host. The guests included the visitors from the University of Kansas and from the Kansas State Agricultural College, and in addition two members from the civil engineering department of the University of South Dakota, Prof. R. O. Newcomb and Mr. John W. Wright.

The first assembly of the group to which both host and guests always attach much importance was at the Grand Hotel, the stated object being dinner but providing the equally pleasurable occasion again of experiencing that feeling of great friendliness that has always characterized these gatherings. This meeting was continued in the Mechanical Engineering Building of the University for the evening program, with Professor F. A. Russell of Kansas University presiding as the president of the section. The minutes of last year's meeting at the Kansas State Agricultural College, as reported by Prof. R. S. Tait of Kansas University, were read and approved.

The first speaker of the formal program was to have been Dean F. W. Upson of the Graduate College, University of Nebraska, but on account of his absence from Lincoln a paper prepared by him on the subject "Graduate Work for Engineering Students" was read by Dr. C. S. Hamilton of the University of Nebraska. Herein was stressed the fact that the graduate process is an individual matter, embodying intensive study in the methods of research and in the direction to develop initiative, and that it should establish new processes and new laws distinctly beyond the range of a four year course. The formal discussion that followed was lead by Dean R. A. Seaton of the Kansas State Agricultural College and Dean O. J. Ferguson of the University of Nebraska.

The second speaker was Professor H. J. Kesner of the University of Nebraska who spoke on "Deformeter Apparatus for the Mechanical Analysis of Rigid Frames." After a short review of the essential theory underlying the method, Mr. Kesner demonstrated his talk by the use of the Begg's deformeter apparatus on a model of a three story, two bay structure. Much interest was supplied by this talk as evidenced by the number who remained after the meeting to examine further the apparatus and model.

On the appointment by the president of the nominating committee, consisting of Professor Edison of Nebraska University as Chairman, Professor H. A. Rice of Kansas University, and Professor L. E. Conrad of Kansas State Agricultural College, the evening meeting adjourned.

The meeting was resumed at 9:15 the following morning by a very spirited talk on the "S. P. E. E. Summer Session at Purdue," given by Professor Edward Anderson of the University of Nebraska, in which he gave many interesting highlights on the programs and the personalities of the session. The remainder of the formal program was given over to the subject of "Aeronautical Engineering Courses," the discussion being given by Professor Earl D. Hay of the University of Kansas, Professor C. E. Pearce of the Kansas State Agricultural College and Professor J. W. Haney of the University of Nebraska.

The Nominating Committee submitted the following nominations: Professor J. P. Calderwood of the Kansas State Agricultural College for President, Professor E. E. Brackett of the University of Nebraska for Secretary and Professor Earl D. Hay of the University of Kansas as Chairman of the Program Committee. The report of the Nominating Committee was accepted and, as is the custom, the nominees were officially declared elected.

Professor Russell, still presiding as president, was the spokesman for all of the guests present at the meetings when he thanked the Engineering Faculty of the University of Nebraska for the splendid entertainment that had been arranged, mentioning specifically Professor E. E. Brackett who

had served as Chairman of the Program Committee for this fine meeting. Mr. Russell also extended the invitation to the Section in the name of the members from the University of Kansas, to attend the annual meeting next year at Lawrence, Kansas.

The meeting adjourned to reassemble at the Nebraska State Capitol where an inspection trip, arranged by Professor M. I. Evinger of the University of Nebraska, was very much appreciated. The monumental features of the structure were stressed—with its vast symbolism—as well as its strictly utilitarian purposes. The last assembly of the group was at the Lincoln Chamber of Commerce where the luncheon was very greatly enjoyed.

J. H. ROBERT,
Secretary.

A meeting of the **New England Section** was held Saturday, November 9, at the Harvard Engineering School in Cambridge, Massachusetts.

The morning was devoted to registration at Pierce Hall and to inspection of the Harvard buildings. At twelve o'clock all delegates were guests of the Harvard Engineering School for luncheon at the Harvard Union, eighty-seven being present. At the close of the luncheon Dean Cloke, the chairman of the section, introduced Dean H. J. Hughes of the Harvard Engineering School, who welcomed the delegates. Professor C. H. Berry then told of plans for the afternoon and evening. Following the luncheon there was a brief inspection of the collection of the glass flowers at the Peabody Museum.

The afternoon session was called to order by the Chairman, Dean Cloke, at 2:05 P.M. He introduced Mr. R. E. Doherty, Consulting Engineer of the General Electric Company, who discussed the problem of orientation of engineering students to industry, and told how his company was handling this problem. He was followed by Mr. E. S. Mansfield, Head of the Educational Bureau of the Edison Electric Illuminating Company of Boston, who discussed the problem of the student finding the type of work for which he was best suited, and

pointed out some experiences of his company with cooperative students. These papers were discussed by Professor W. H. Timbie of M. I. T. and Mr. O. W. Eshbach of the American Telephone and Telegraph Company. After a brief recess Chairman Cloke introduced in succession the following three men who spoke on the summer session for teachers of Mechanical Engineering at Purdue University: George S. Stetson, Associate Editor, American Society of Mechanical Engineers, C. E. Davies, Acting Secretary, American Society of Mechanical Engineers, P. W. Swain, Associate Editor, *Power*. Following a brief discussion Professor H. P. Hammond, representing the Society for the Promotion of Engineering Education, announced the summer sessions for 1930 as follows: Civil Engineering at Yale University, New Haven, and Engineering Drawing at the Carnegie Institute of Technology, Pittsburgh.

The meeting adjourned at 4:30 for a trip of inspection through the laboratories of the Harvard Engineering School.

At 6:30 the delegates assembled at the Harvard Union for dinner, following which Chairman Cloke introduced Dean Hughes who took charge of the meeting. The subject was "What Effect Has the Investigation of Engineering Education Had on My Institution?" Dean Hughes called on representatives of different institutions to answer this question, as follows: Professor H. P. Hammond of Brooklyn Polytechnic Institute, Professor James A. Hall, of Brown University, Professor N. E. Wheeler of Colby College, Dean Paul Cloke of University of Maine, Professor V. Bush of Massachusetts Institute of Technology, Dean Carl S. Ell of Northeastern, Professor L. W. Hitchcock of the University of New Hampshire, Professor Edgar MacNaughton of Tufts.

Before continuing the regular program, Dean Anthony of Tufts, who for five years was chairman of the New England Section, was called on for a few words. He was followed by C. Frank Allen, Professor Emeritus at the Massachusetts Institute of Technology, and one of the charter members of the Society. The latter referred to the work done by Professor Swain, and Professor Scott of Yale then moved that

the greetings and best wishes of the New England Section be transmitted to Professor Swain by the secretary.

Continuing the regular order of the program, Professor Wilson responded for the Wentworth Institute and Professor Howe for Worcester Polytechnic Institute, Dean Hughes then discussed the situation at Harvard, and this part of the program was continued by Professor C. F. Scott of Yale. In general the different members spoke of changes which had come in the curriculum, methods of instruction, or in their ideals, as either a direct or an indirect result of this investigation.

Robert I Rees, President of the Society for the Promotion of Engineering Education, then gave a short address telling us some of the problems now before the Society. Ninety three delegates registered at the meeting, the following New England institutions being represented: Brown University, Colby College, Harvard, Massachusetts Institute of Technology, University of Maine, University of New Hampshire, Norwich University, Worcester Polytechnic Institute, Yale University. Professor Hastings then presented a resolution of thanks to our hosts, to the speakers, and to those who had helped in arranging the program. The meeting adjourned at 10:00 P.M. Ninety-three registered their attendance.

JAMES A. HALL,
Secretary.

COLLEGE NOTES

The year 1930 marks the completion of twenty years of continuous service at the School of Engineering, Northeastern University, by Professor William Lincoln Smith, Chairman of the Department of Electrical Engineering.

Dr. Carl F. Muckenhoupt has recently been appointed Assistant Professor of Electrical Engineering, bringing the strength of the department to five men. Professor Muckenhoupt is a graduate of Williams College and of the Massachusetts Institute of Technology at which he completed his work for the doctorate. Dr. Muckenhoupt was formerly affiliated with the Westinghouse Electric and Manufacturing Company and with the Western Electric Company where he was engaged upon research and development work.

A new office, devoted exclusively to student problems, has been established this year with the appointment of Harold W. Melvin as Dean of Students. Dean Melvin has long been active in the School as Chairman of the Department of English and Director of Student Activities. In his new capacity he will direct freshman advisory work, co-ordinate the efforts of faculty advisors, and handle matters relating to loans and scholarships.

Other new appointments to the faculty this year are as follows: C. David Johnson, Assistant Professor of Physics; Laurence F. Cleveland, Instructor in Drawing; Malcolm C. Davis, Instructor in Co-ordination; Henry K. Holt, Instructor in Mathematics; Frank H. LaBree, Instructor in Electrical Engineering; Alfred M. McCoy, Instructor in English and Coach of Basketball and Baseball; Benjamin F. White, Instructor in English and Director of Musical Clubs.